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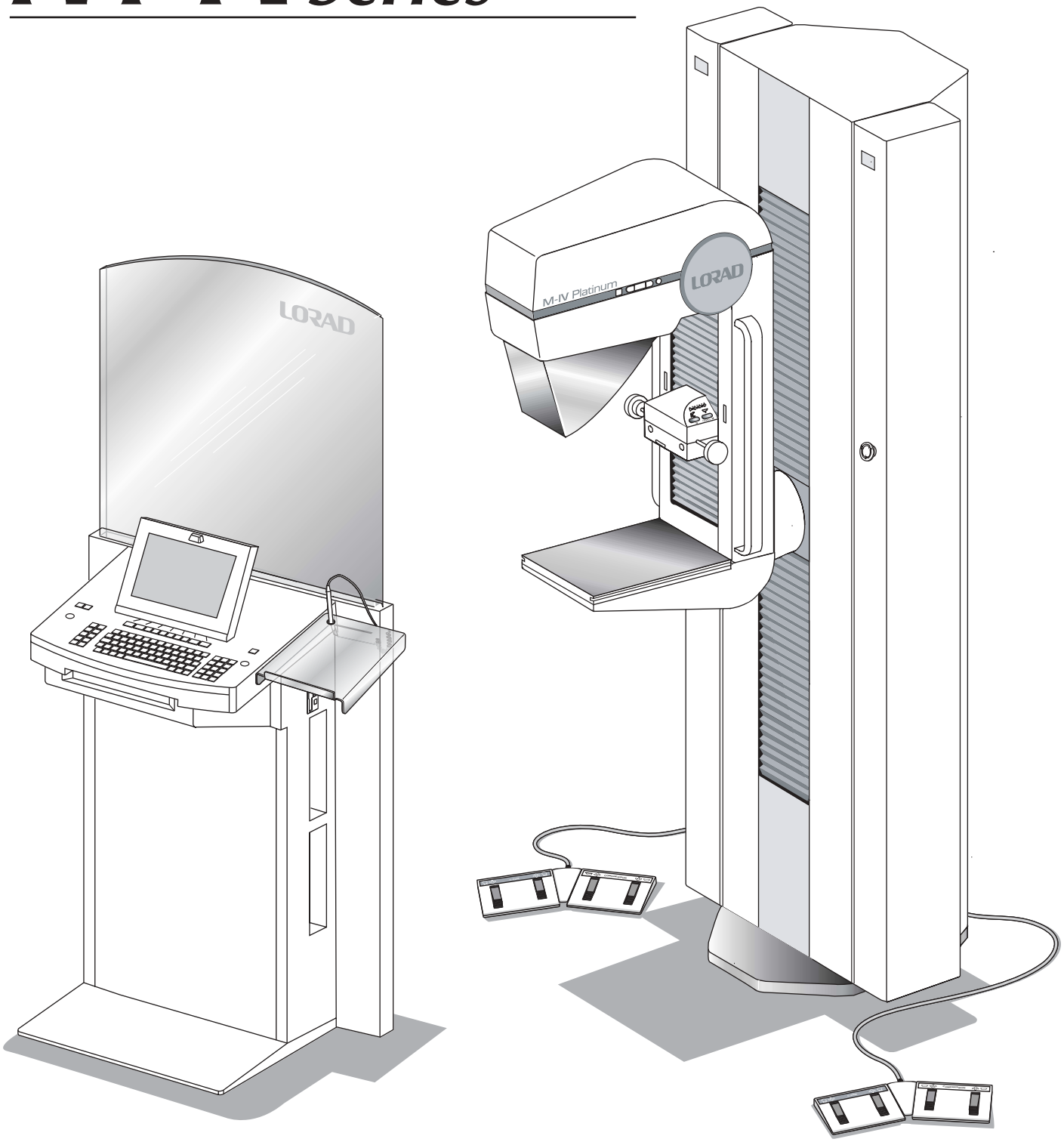

LORAD
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Service Manual
9-500-0276

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Service Manual

for M-IV Series Mammography Systems

Second Edition

Part Number 9-500-0276,
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Preface

1.0 Using the Service Manual

The first four chapters of this service manual are designed to provide a service representative with a sequence for setting up and calibrating the M-IV. The remaining chapters detail the maintenance procedures. General description of the contents of each chapter is as follows:

Chapter 1: General Information

Contains general system descriptions, x-ray, electrical and mechanical safety precautions, and compliance information.

Chapter 2: System Installation

Contains information for unpacking, positioning, and installing the unit. Attaching the interconnections, mounting the accessories, connecting to power, and the power up sequence are covered.

Chapter 3: System Setup

Contains information on system setup (switch settings and connections), functional checks, setting system defaults, calibrating the exposure control system, and final set up checks.

Chapter 4: Performance/Compliance Checks and Adjustment Procedures

Contains the procedures that verify system compliance, including performance checks for the x-ray tube, the automatic exposure control system, and the x-ray field.

Chapter 5: Covers, Panels, Fuses and Jumpers

Contains information detailing the removal of the unit's covers and panels, the locations and ratings of the fuses used on the system, and the jumper settings for each of the circuit boards.

Chapter 6: Operator Console Maintenance

Contains the information necessary to repair, and adjust the various assemblies and subsections of the Operator Console.

Chapter 7: Gantry Maintenance

This section provides the information necessary to repair, and adjust the various assemblies and subsections on the Gantry, including the x-ray generation system and the C-arm movement system.

Chapter 8: C-arm Assembly Maintenance

This section provides the information necessary to repair, and adjust the various assemblies and subsections of the M-IV C-arm, including the beam limiting assembly, the compression assembly, and the image receptor support assembly.

Chapter 9: Parts List

Contains tabular listings of the replacement parts for the M-IV Mammography System.

Appendix A: Specifications

Contains system specifications, including performance specifications, x-ray tube and exposure specifications, compression specifications and beam limiting specifications.

1.1 Warnings, Cautions and Notes

Definitions of Warnings, Cautions and Notes used throughout this manual are as follows:

WARNING!

Warnings point out procedures that you must follow precisely to avoid injury to yourself or others.

CAUTION!

Cautions point out procedures that you must follow precisely to avoid damage to equipment, loss of data, or corruption of files in software applications.

CAUTION!

ESD Cautions identify potential damage to electronic components caused by static electricity. Always wear a grounded electrostatic discharge strap when handling static sensitive components identified by this caution.

Note…Notes indicate important information that must be followed to ensure the proper operation of the system.

2.0 Acronym List

The following table provides a list of the common Acronyms used throughout the M-IV Service Manual.

Table P-1: List of Acronyms for M-IV

Acronym	Definition
21 CFR	FDA Code of Federal Regulations, Title 21
ACR MAP	American College of Radiology Mammography Accreditation Program
ACR/CDC	American College of Radiology/Center for Disease Control
AEC	Automatic Exposure Control
B.E.M.	Breast equivalent material
CPT	Common Procedural Terminology
DSM	Digital Spot Mammography
DMM	Digital Multimeter
EMC	Electro-magnetic Compatibility
EMI	Electro-magnetic Interference
EMO Switch	Emergency Off Switch
ESD	Electro-static Discharge

Table P-1: List of Acronyms for M-IV

Acronym	Definition
F.A.S.T.	Fully Automatic Self-Adjusting Tilt Paddle
H.V.	High Voltage
HTC	High Transmission Cellular Grid
HVL	Beam Quality Half-Value Layer
IR	Image Receptor
IRSD	Image Receptor Support Device
LVPS	Low Voltage Power Supply
Mag	Magnification mode
Mo	Molybdenum
MQSA	Mammographic Quality Standards Act
MPU	Microprocessor Unit
N	Newtons
OD	Optical Density
Rh or Rho	Rhodium
RIS	Radiology Information System
SID	Source to Image Distance
SL or STL	StereoLoc II
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
VTA	Vertical Travel Assembly

Chapter 1: General Information

1.0 Intended Use

The M-IV Mammography System is intended to produce radiographic images of the breast. Its specific intended use is for screening and diagnostic mammography.

2.0 Introduction

The M-IV Mammography System combines LORAD Clean Power Mammography technology with a microprocessor controlled unit to make a complete diagnostic imaging system. The full-featured machine provides manual or automatic x-ray control and accommodates a full range of options, including stereo tactic localization and digital imaging capabilities.

3.0 Unit Description

The M-IV is equipped with a bi-angular, dual focal spot x-ray tube, and features four menu-driven exposure modes:

- **Manual** - all exposure factors entered by user
- **Auto-Time** - system determines exposure duration
- **Auto-kV** - system determines exposure kV and duration
- **Auto-Filter** - system determines all exposure factors

The unit accommodates all LORAD manufactured attachments, such as cassette holders, Bucky devices, Compression Paddles, Localization Paddles, and the Magnification Table. The unit also adapts for use with the LORAD StereoLoc II Localization and Biopsy System, and the LORAD DSM Digital Spot Mammography System.

Note …LORAD StereoLoc II and LORAD DSM are not available for use with the M-IV Mobile.

The unit's modular design separates the operator interface (Operator Console) and the patient support devices (Gantry). This permits configuration of the M-IV to differing space allotments including installation as a mobile unit (M-IV Mobile).

The M-IV incorporates multiple microprocessors that control the user interface, mechanical operations (C-arm and collimator movement), the x-ray generation system, and the automatic exposure control system.

The control system contains built-in diagnostic routines that monitor operation before, during, and after an x-ray exposure. If these diagnostic routines detect a malfunction, further operation is prevented until the detected fault is cleared. All fault messages are displayed on the Operator Console Flat Panel Display.

3.1 Required Tools and Equipment

The following is a list of the tools and equipment necessary to perform the maintenance procedures detailed in this manual.

- Standard Hand Tools
- Oscilloscope
- Digital Multimeter (DMM)
- Hex (Allen) Wrench Set - standard
- Light Detector Model 268P (or equivalent)
- Light Meter - UDT Instruments, Model 351 (or equivalent)
- Radiation Meter with probe (calibrated in the Mammographic ranges)
- Aluminum Filter Pack - Ultra-high purity type 1145 (99.99% pure)
- 3/8" Drive Socket Set
- P.M.M.A. Acrylic Attenuators (or B.E.M.) - 1 cm thick, min. of 10 x 12.5 cm
- P.M.M.A. Acrylic Attenuators (or B.E.M.) - 2 cm thick, min. of 10 x 12.5 cm
- P.M.M.A. Acrylic Attenuators (or B.E.M.) - 4 cm thick, min. of 10 x 12.5 cm
- High Voltage Divider with a ratio of 10,000:1 or 100,000:1
- High Voltage Adapter Cable (LORAD P/N 2-425-3015)
- mAs Meter
- Light Field Alignment Bars (9-060-0173)
- Light/X-ray Field Template (9-060-0140)
- Field Service Belt Adjustment Tool (9-061-0107)
- Loctite, 242 Blue (2-580-0542)
- Masking Tape
- Laptop Computer (P.C.) with serial port
- Mammography Phantom—ACR MAP
- PLCC EPROM Remover
- Serial Cable with 2 x 5 header on one end
- Lead Shield/Blocker - Approximately 4 x 4 cm
- Feeler Gauges - 0.015 and 0.020
- Compression Scale/Force Gauge
- Aluminum Aperture for Light Meter - 1 mm diameter

Note…B.E.M. refers to breast equivalent material, such as BR-12, 50/50 Breast Tissue equivalent material, or P.M.M.A. Acrylic.

4.0 Safety

This portion of the manual details electrical, mechanical, and radiation safety, as well as precautions concerning static electricity and magnetic media storage. The equipment complies with IEC 601 (General, Collateral and applicable Particular Standards), UL 2601 and CSA 22.2601.

4.1 Electrical Safety

The system is classified as CLASS I, TYPE B permanently connected equipment as per IEC 601-1 and Class II Medical Devices per 21 CFR 892.1710. There are no special provisions to protect the system from flammable anesthetics or ingress of liquids.

Three Emergency OFF (EMO) switches are provided. Two switches are located on the Gantry (one on each side) and the third switch is located on the operator console. Each of these switches disables power to the entire system.

WARNING!

Only qualified electronic technicians who are certified and experienced in the maintenance and repair of high voltage x-ray equipment should attempt to service this equipment.

WARNING!

LETHAL voltages are present within the interior of the unit. Use extreme caution to avoid contacting, directly or indirectly (through tools), any connector pins, terminals, or test points. Remove all jewelry before working on the unit, and avoid wearing loose fitting clothing.

WARNING!

Never perform service alone. Only service this equipment in the company of someone who is capable of rendering aid should an accident occur.

4.2 Static Electricity and Magnetic Field Safety

Always be aware of the effects static electricity has on electronic components. Take precautions for the safe handling and storage of electronic media.

CAUTION!

Electronic components within the unit are extremely sensitive to static electricity. ALWAYS use a grounding electrostatic strap when handling these sensitive components.

CAUTION!

The floppy diskettes store data magnetically. DO NOT store or place any magnetic media near or on devices which produce magnetic fields or stored data may be lost.

4.3 Mechanical Safety

- The C-arm rotation motor stops upon loss of power and braking is ensured.
- The Automatic Compression Release Mode is disabled when a Localization Paddle is installed.
- All C-arm functions (vertical drive, rotation, compression up/down, compression release, light field, etc.) are simultaneously operable. Vertical drive and rotation are disabled during the presence of at least 13 lb of compression force.

4.4 Radiation Safety

The radiation safety of the unit complies with all requirements of 21 CFR, Part 1020, and complies with IEC 601.

The operator control panel contains two x-ray exposure buttons which must be pressed simultaneously for the entire duration of the exposure and released before initiating another exposure. An audible tone will sound for the entire time x-rays are produced.

The exposure duration is controlled by the following normal conditions:

- The X-ray exposure switches must be held continuously
- By the microprocessor pre-set back-up-time
- By an independent “safety” hardware back-up-timer
- By detection of a generator fault.

The control electronics prevent the unit from initiating an X-ray exposure unless:

- The cassette is installed with Bucky use
- The room door interlock is closed
- The X-ray exposure footswitch interlock is closed (NYC requirement.)
- Two X-ray switches must be activated simultaneously.

The radiation shield provides a minimum of 0.5 mm of lead equivalent attenuation at 35 kV.

5.0 Unit Layout

The M-IV Mammography Unit consists of three major assemblies:

- the Operator Console
- the Gantry
- the C-arm

5.1 The Operator Console

The Operator Console controls x-ray exposures through the operator interface (Flat Panel Display screen and keyboard on the Console). Data and technique inputs are made via the keyboard while the screen displays all exposure options and selections for the selected exposure mode (Manual, Auto-Time, Auto-kV, or Auto-Filter). Data fields on the screen list patient information (name, identification number, gender, etc.), exam data (view, CPT code), and technologist identification data. Status lines also inform the user as to the condition of the accessories (printer, AutoFilm ID, compression, image receptor), in addition to the current date and time. The display screen provides illumination for the keyboard and is manually adjustable, forward and back.

The Operator Console houses the following components:

- Keyboard (for data and technique input)
- X-ray Exposure Buttons
- Console Display (operator interface)
- AutoFilm ID
- Low Voltage Power Supply
- Operator Interface Microprocessor
- System Peripheral (floppy disk drive)
- ON and OFF Buttons
- Remote Compression Release Button
- Emergency OFF Switch
- Keyboard Illuminator

Refer to Figure 1-1 to identify the Operator Console components.

Legend for Figure 1-1

1. Display Screen
2. Emergency OFF Switch (left side of console)
3. Data Entry / Exposure Control Keyboard
4. AutoFilm ID
5. Cassette Storage (Both Sides)
6. Radiation Shield
7. Bar Code Reader (optional)
8. Floppy Disk Drive
9. Input Power/Data Cable Connector Panel (rear of console)
10. Keyboard Illuminator

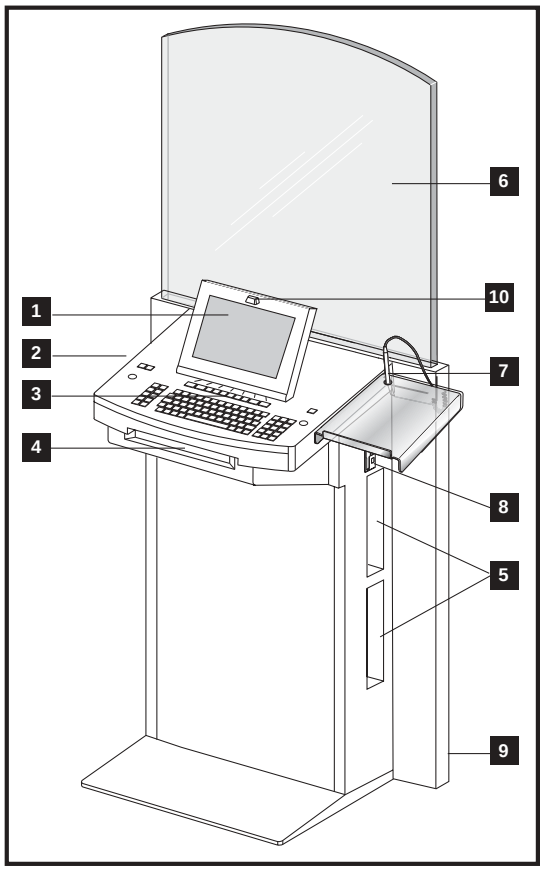


Figure 1-1: M-IV Operator Console—Components

5.2 The Gantry and C-Arm

The Gantry is the main support for the C-arm and tubehead assembly. It is permanently connected to the input power source, and supplies power to all unit subsystems through an isolation transformer.

The following components or subsystems are found in the Gantry:

- Exposure Control Electronics
- High Voltage Generator
- C-arm Rotation Drive
- C-arm Vertical Drive
- Power Distribution (Input Power Circuit Breaker)
- Vertical Travel Assembly

The M-IV C-arm, which suspends from the pivot tube on the Gantry, is made up of the following components or subsystems:

- X-ray Tube
- Beam Limiting Device
- Compression Device
- C-arm Controls
- IRSD
- Accessory Detect Systems
- Automatic Exposure Control System
- Bucky Device Control

Refer to Figure 1-2 to identify the Gantry and C-arm components.

Legend for Figure 1-2

1. C-arm Angle Display
2. Tubehead
3. Tubehead Controls
4. Face Shield
5. Compression Displays and AEC Position Display
6. Compression Device
7. Emergency OFF Switch (2)
8. IRSD
9. Dual Function Footswitch
10. Patient Handle
11. C-arm Controls
12. C-arm Pivot Tube
13. Circuit Breaker (rear of gantry)
14. Footswitch Receptacles (rear of gantry)
15. C-arm Rotation Control (rear of IRSD)
16. AEC Detection Position Handle (bottom of IRSD)

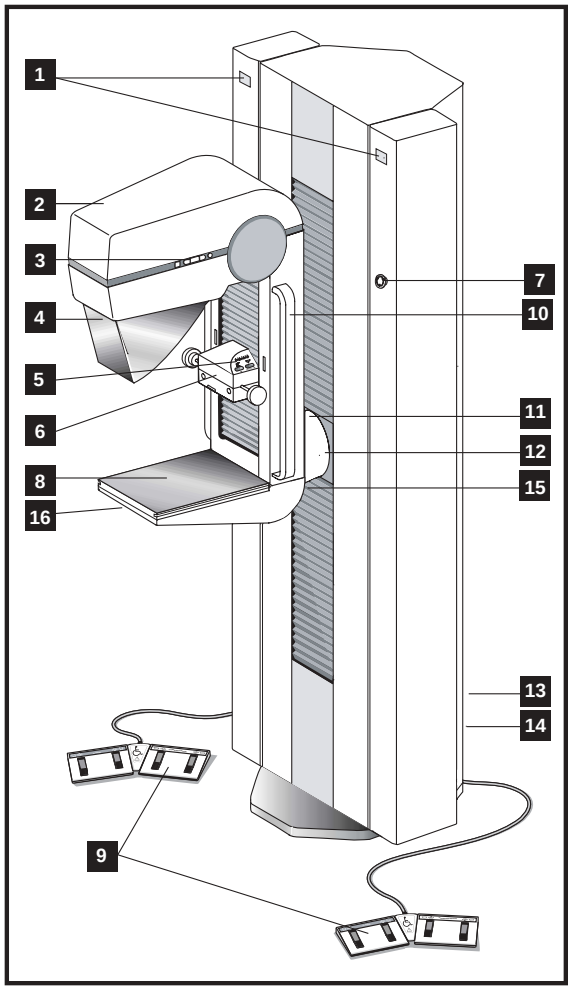


Figure 1-2: M-IV Gantry and C-arm—Components

6.0 Compliance Data

The following section details the M-IV compliance requirements and the manufacturer's responsibilities.

6.1 Responsibility Statement

LORAD is responsible for the effects of reliability and performance of this equipment with the following provisions:

- The electrical installation of the room complies with the appropriate requirements.
- The equipment is used in accordance with instructions for use.
- To ensure safe operation, assembly operations, extensions, readjustments, modifications, or repairs must be performed by authorized persons only.

6.2 Compliance Statement

The manufacturer of this device complied with the following requirements applicable at the time of manufacture:

- ISO 9001
- ISO 13485
- EN 46001
- FDA Quality System Regulation (QSR), 21 CFR 820

The system is designed, tested, and classified to comply with the following requirements:

- IEC 601-1
- IEC 601-2-7
- IEC 601-2-32
- IEC 601-1-2
- IEC 601-2-28
- IEC 601-2-45
- EMC Directive
- Medical Device Directive
- UL 2601
- CSA 22.2 No. 601.1
- 21 CFR Subchapter J

6.3 Certifiable Components

These components are identified using individual serial numbers (refer to Table 1-1)

Table 1-1: M-IV Certifiable Components

ITEM	MANUFACTURER	MODEL #	LABEL #	LOCATION
X-ray Tube	Toshiba	E7290AX	4	Tubehead
X-ray Tube	Varian	M113R/B115	4	Tubehead
Bucky (18 x 24 cm) - Linear Grid	LORAD	4-000-0242	2	Accessory
Bucky (24 x 30 cm) - Linear Grid	LORAD	4-000-0244	2	Accessory
Bucky (18 x 24 cm) - HTC Grid	LORAD	4-000-0241	2	Accessory
Bucky (24 x 30 cm) - HTC Grid	LORAD	4-000-0243	2	Accessory
Magnification Table	LORAD	4-000-0246	2	Accessory
High Voltage Generator	LORAD	4-000-0014	2	Gantry
Beam Limiting Device	LORAD	4-000-0029	2	Gantry
X-ray Control	LORAD	4-000-0002	2	Console
Image Receptor Support Device	LORAD	4-000-0140	2	C-arm
Image Receptor Support Device	LORAD	4-000-0141	2	C-arm

IMPORTANT! When replacing a certified component that is concealed by a surface (i.e., cover, panel, etc.), the component's duplicate label on the exterior of the unit MUST BE replaced at the time of service.

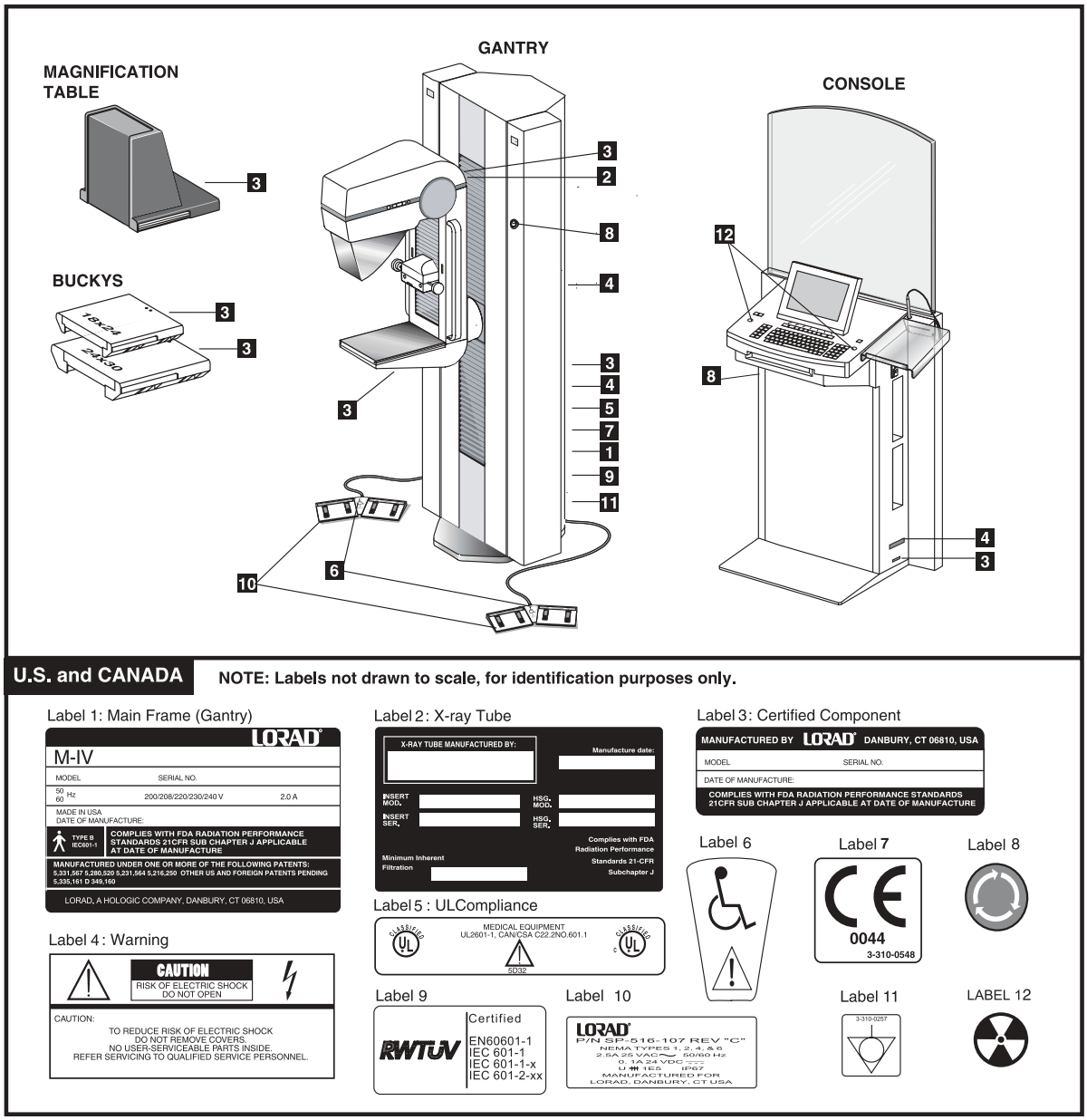
IMPORTANT! When replacing a surface (i.e., cover, panel, etc.) that has a certified component duplicate label(s), a label(s) that represents the certified component label(s) MUST BE placed on the new surface at the time of service.

6.4 Compliance and Identification Label Locations

The unit conforms to all applicable FDA regulations. Labels addressing the certifiable components are fixed to the unit at several points. Refer to Figure 1-3.

Obtain each device's serial number from the main identification label and write it down on the inside cover of both the Operator's and Service manuals. The Main Frame serial number is used to track units for warranty and service purposes, and will be requested should it become necessary to contact LORAD regarding the device.

Note…LORAD Bucky's 18 x 24 cm and 24 x 30 cm are certified components which are not subject to 21 CFR1020.30(d) and therefore do not have to be reported on form FDA 2579 (Ref BRH: Doc MA3499).



IMPORTANT ! *When replacing a certified component that is concealed by a surface (i.e., cover, panel, etc), the component's duplicate label on the exterior of the unit MUST BE replaced at the time of service.*

IMPORTANT ! *When replacing a surface (i.e., cover, panel, etc.) that has a certified component duplicate label(s), a label(s) that represents the certified component label(s) MUST BE placed on the new surface at the time of service.*

Figure 1-3: Label Locations

Chapter 2: System Installation

1.0 Unpacking The Unit

This section contains procedures for unpacking, setting up, positioning, and installing the M-IV Mammography System. Procedures for measuring the input power receptacle voltage, and for tapping the unit's isolation transformer are also included.

1.1 Receiving Instructions

The unit is shipped in three main crates which contain the following:

- the Gantry
- the Operator Console
- the Radiation Shield

Before opening the crates, perform the following:

- Inspect each crate and box for external damage
- Note any observable damage on the shipping manifest
- Notify LORAD of any incident

If shipping damage is of a concealed nature, contact the carrier as soon as such damage is found, and request an inspection for shipping damage. Normally, any claims for shipping damage must be completed within 15 days of receiving the shipment.

After the external inspection, perform the following:

- Open all crates and boxes
- Check contents against packing list / sales order
- Report ALL discrepancies to LORAD

If it is necessary to repack any items for future installation, use the original packaging materials.

CAUTION!

DO NOT attempt to lift or move the Gantry by the C-arm, or by either hinged door on the left and right side of the Gantry frame, or damage may occur.

CAUTION!

Avoid damaging the Radiation Shield by impact or scratching. DO NOT store the radiation shield flat or damage may occur.

1.2 Un-crating—Gantry

The Gantry is crated and shipped in the prone position. After removal from the shipping crate, it will be necessary to upright the Gantry before it can be mounted into position.

1. Cut the straps that secure the cardboard shipping carton to the shock-mounted wooden pallet.
2. Lift the carton from the wooden pallet.
3. Carefully remove all shipping materials (i.e., foam padding, tie-downs, straps, shipping wrap, etc.) that protect the Gantry during shipment.
4. Lift all accessory boxes from the pallet.
5. Carefully push the entire Gantry assembly forward, in the direction of the base plate "dolly", until the "dolly" frame clears the pallet (approximately 1 foot). (See Figure 2-1: Un-crating the Unit.) Use two people (MINIMUM) to lift the Gantry upright onto the attached shipping "dolly".
6. Carefully roll the Gantry to the installation site.

Note…It is the responsibility of the dealer to return the Gantry dolly to LORAD via the supplied shipping documents. Refer to LORAD Field Service Technical Bulletin (No. 94-0093) for policy details.

1.3 Un-crating—Operator Console

The Operator Console is crated and shipped upright, with the console display not installed and without the radiation shield attached. After removal from the shipping crate, the Operator Console may be carried to its final mounting location.

1. Cut the straps that secure the cardboard shipping carton to the shock-mounted wooden pallet.
2. Lift the carton from the wooden pallet.
3. Carefully remove all shipping materials (i.e., foam padding, tie-downs, straps, shipping wrap, etc.) from the Console.
4. Lift all accessory boxes from the pallet, including the console display.
5. Carefully lift the Operator Console off the pallet and place it gently on the floor.

1.4 Unpacking—Accessories

The console display screen and all accessories are packed in separate boxes and containers which are stored in one of the two main shipping containers (Gantry or Console). The accessory containers are specially designed to minimize shipping damage and to facilitate equipment storage. Note, however, that the radiation shield is shipped in its own box.

1. Check each item for damage.
2. If it is necessary to repack any items for future installation, use the original packaging materials.
3. Open the radiation shield container and carefully remove the glass shield.
4. Check the shield for nicks, cuts, scratches or other damage.
5. Place all accessories in a storage area or compartment near the installation site.

Note….The storage area should provide convenient access to each accessory, but should not interfere with C-arm or patient movement.

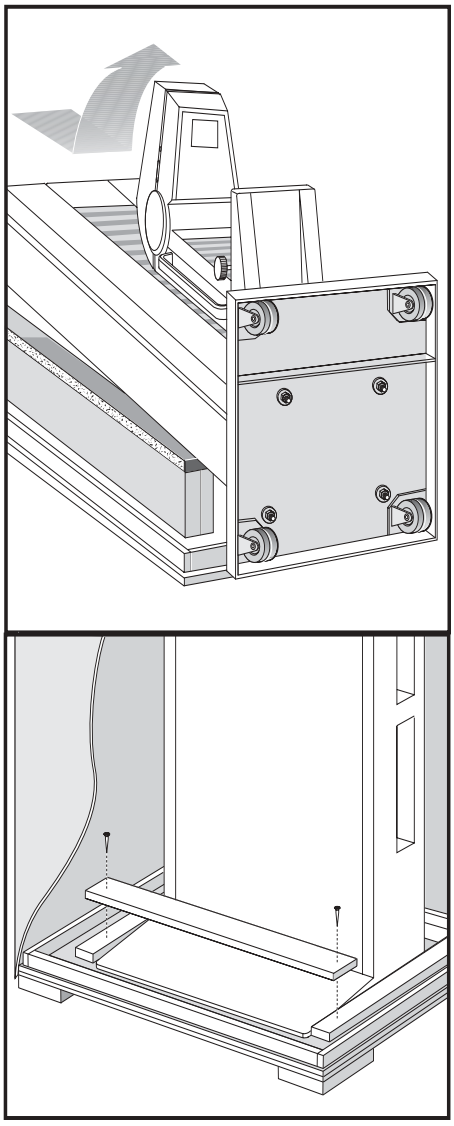


Figure 2-1: Un-crating the Unit

2.0 Unit Installation

Note that the installation site (exam room) must be properly prepared by qualified personnel prior to installing the unit. Verify that the following are complete prior to transporting the unit to the installation site:

- Floor modifications (anchor bolts for Gantry and Console)
- Pre-installed Wire-runs and Conduits
- Voltage source facilitating a hard wire configuration

Position the Gantry and the Operator Console in the appropriate room. Pay particular attention to the following:

- Clearances for C-arm rotation and rear Gantry access
- Positioning of Console and radiation shield relative to x-ray source
- Space for patient movement

Avoid obstructions in the room that may hinder access to the Operator Console or the patient. Provide convenient storage for patient records, film, cassette holders, and other accessories.

2.1 Installation—Gantry

The Gantry mounts to the floor onto pre-installed, threaded floor anchors. Four floor anchors are required to secure the Gantry to the floor. (See Figure 2-2: Installation—Gantry.) It is the responsibility of the health-care facility to ensure that the Gantry mounting points (floor anchors) meet the federal, state, and/or local building codes for floor mounting and load requirements, and all OSHA requirements for safety.

1. Move the Gantry into position near the pre-drilled floor anchor holes.
2. Remove the bolts that secure the Gantry to the shipping "dolly", then carefully remove the "dolly" from beneath the Gantry baseplate.

WARNING!

It will require two people to remove the unit safely from the shipping dolly.

3. Carefully move the Gantry so that the baseplate mounting holes align over the threaded floor anchors.

CAUTION!

NEVER maneuver the Gantry by lifting, pulling, or pushing on the C-arm or the tubehead assemblies.

4. Level the Gantry by adjusting the threaded Inserts in each of the baseplate mounting holes.
5. Secure the Gantry to the floor using the recommended anchor bolts and washers.

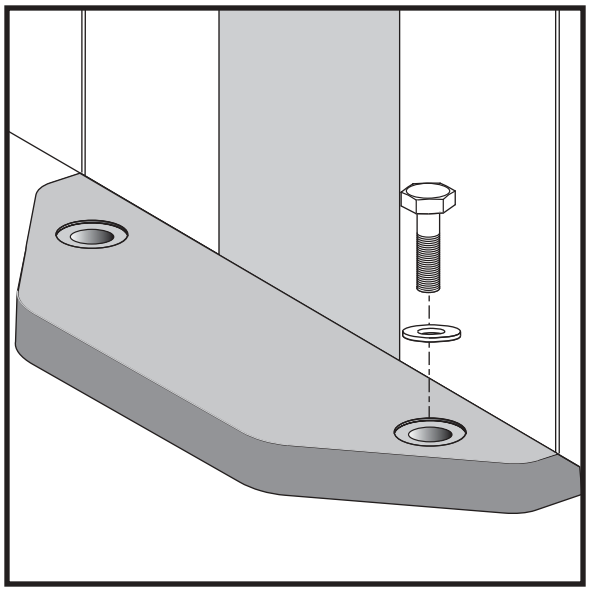


Figure 2-2: Installation—Gantry

2.2 Installation—Operator Console

The Console mounts to the floor onto four pre-installed floor anchors (threaded). It is the responsibility of the health-care facility to ensure that the Console mounting points (floor anchors) meet the federal, state, and/or local building codes for floor mounting and load requirements, and all OSHA requirements for safety.

1. Remove the front panel from the Operator Console to access the mounting holes (refer to Chapter 5: Covers, Panels, Fuses and Jumpers, Section 2.1 for remove and replace procedures for the Operator Console Covers).
2. Move the Operator Console near the pre-installed floor anchors. Note that it may require two people to move the console into position.
3. Carefully position the Console over the floor anchors so that the mounting holes align over the threaded floor anchors.
4. Secure the Console to the floor using the required anchor bolts and washers. (See Figure 2-3: Installation—Operator Console.)
5. Install the console display as per Section 2.2.1 below.
6. Replace the Operator Console front panel as per Chapter 5: Covers, Panels, Fuses and Jumpers, Section 2.1.

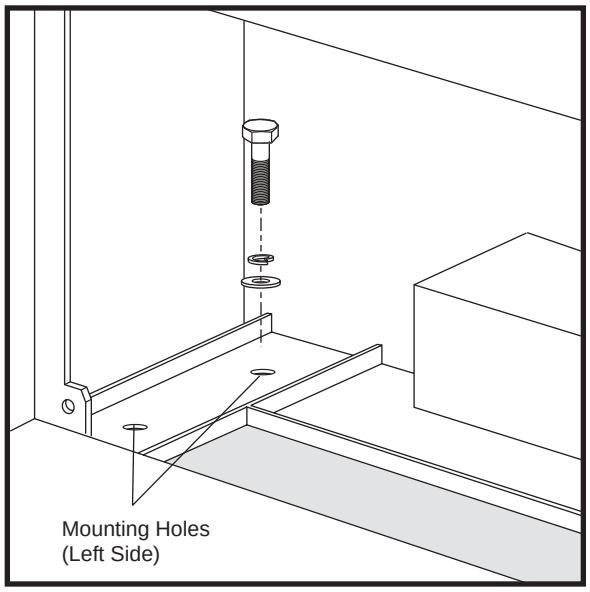


Figure 2-3: Installation—Operator Console

2.2.1 Installation—Console Display

The M-IV Console Display mounts to a bracket beneath the control panel which must be removed to access the mounting hardware (refer to Chapter 5, Section 2.1 for remove and replace procedures for the Operator Console Covers).

1. Remove the Operator Console control panel as per Chapter 5, Section 2.1.
2. Remove the hardware that fastens the console display mount (Item 1, Figure 2-4) to the console frame (Item 2, Figure 2-4). Lift the mount out of the console.
3. Install the console display (Item 3, Figure 2-4) onto the mount, then attach the ground wire provided.
4. Route the console display cables through the slot in the console top shelf.
5. Connect the Console Display ribbon cable to TJ28 on the Operator Interface Microprocessor Board (Item 4, Figure 2-4).
6. Connect the backlight connector to TJ27 on the Operator Interface Microprocessor Board.
7. Connect the keyboard LED cable to P4 (part of the sub-panel cable harness in the front component compartment {Item 5, Figure 2-4}).
8. Align the holes in the display and mount with the holes in the console frame. Install and tighten the mounting hardware.
9. Replace the Operator Console control panel as per Chapter 5, Section 2.1.

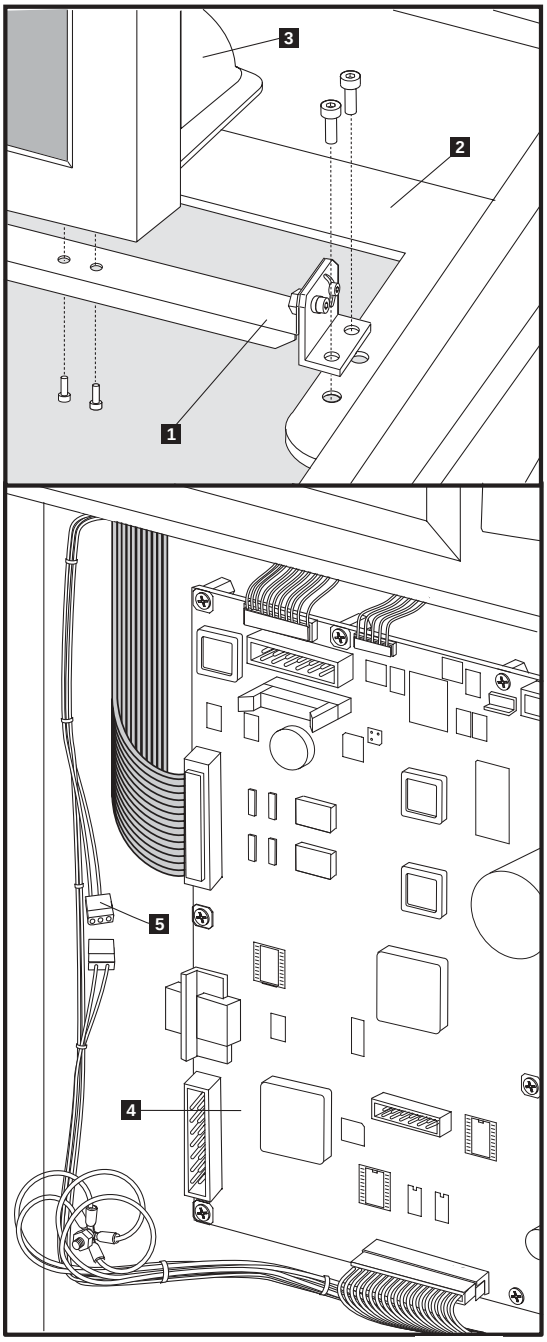


Figure 2-4: Installation—Console Display

2.3 Installation—Footswitches

The system permits attachment of two dual-function footswitches that plug into receptacles inside the Gantry. Use the following procedure to install the footswitches.

WARNING

To avoid accidental footswitch activation, keep both footswitches clear of the patient and C-arm setup area.

1. Remove the lower rear panel from the Gantry by removing the six cover screws.
2. Connect the footswitches to the left and right footswitch receptacles (J3 and J4) by aligning the key to the key hole and pushing the connectors straight in. (See Figure 2-5: Footswitch Connections.)

Note…Either footswitch can be connected to either footswitch receptacle.

3. Replace the lower rear panel to the gantry using six cover screws.
4. To disconnect the footswitch, repeat steps 1 through 3 but instead of pushing the connectors in (Step 2), disconnect by pulling the connectors straight out.

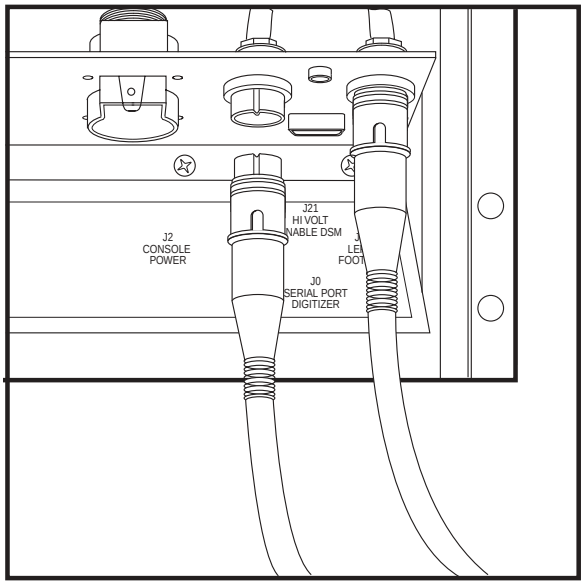


Figure 2-5: Footswitch Connections

2.4 Installation—Radiation Shield

The radiation shield and the shield support are shipped in separate containers and must be fastened to the Console. Set the cable cover aside for mounting after the cable connections are made to the remote console. The two halves of the shield support are shipped already attached. Separate the two halves by lifting the rear shield support slightly, and then pulling it away from the front shield support. Follow the instructions below to install the radiation shield to the M-IV Operator Console.

Note …The M-IV Mobile unit does not come with an operator shield. Shielding will be provided and installed by the M-IV Mobile installer at time of system installation.

1. Position the front shield support so that the mounting holes align with the threaded holes in the rear of the operator console.
2. Secure the front shield support with the four bolts supplied.
3. Lift the radiation shield and place it on the support shelf (attached to the front shield support) with the LORAD logo facing the patient.
4. Align the holes in the shield with the threaded holes in the front support.
5. Position the protective plates (2) over the shield mounting holes.
6. Secure the plates and the shield to the front shield support using the four bolts supplied. (See Figure 2-6: Installation—Radiation Shield.)
7. Position the hooks on the rear shield support so that they align with the slots in the front shield support.
8. Insert the hooks into the slots, then slide the rear support down to secure in place.
9. Mount the front and rear fascia strips onto the shield support as shown.

Note…The fascia strips are self-adhesive and are used to cover the gap between the shield and the shield support.

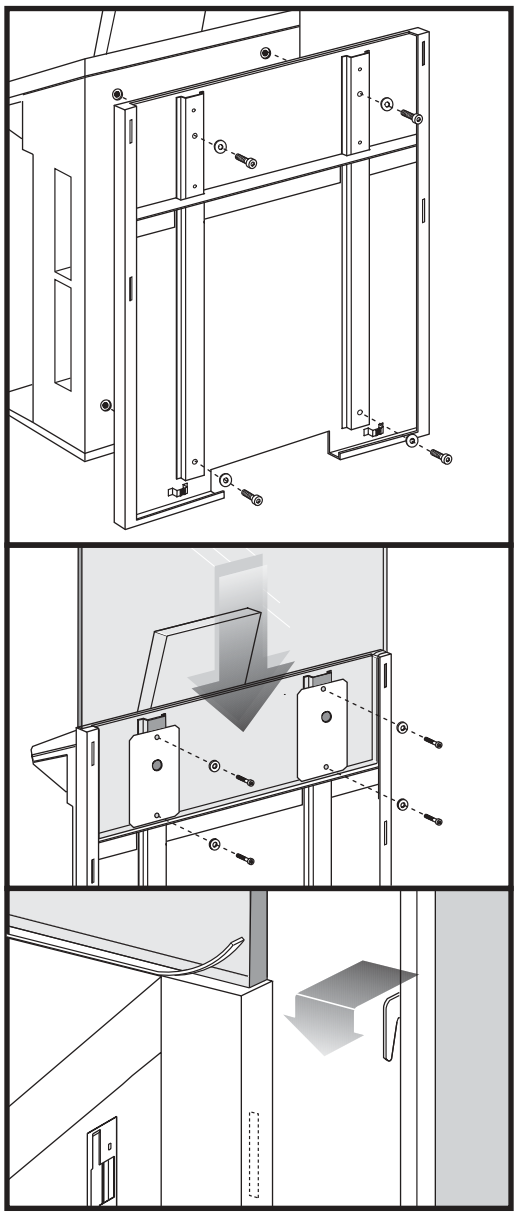


Figure 2-6: Installation—Radiation Shield

2.5 Installation—Bar Code Reader

This procedure details installing the optional Bar Code Reader Wand and the Utility Shelf. Note that this procedure is only valid for units that are shipped Bar Code Reader "ready". Refer to Figure 2-7 throughout the following.

1. Make sure system power is OFF. Remove the Control Console to access the top shelf components. Remove the Console front cover. Refer to Chapter 5: Covers, Panels, Fuses and Jumpers for cover removal procedures.
2. Slip the "D"-sub connector of the Reader Wand through the cutout in the right side of the Control Console. Route the connector around the back side of the AutoFilm ID Assembly.
3. Slip the Reader Wand connector through the access hole in the rear of the top shelf, then route it downward toward the Operator Microprocessor Board. Attach the connector to TJ24 on the Operator Microprocessor.
4. Secure the Reader Wand Cord to the existing wiring harness using several cable ties.
5. Position the Utility Shelf so that the three (3) screws align with the mounting holes in the side of the Control Console. Tighten each screw to secure the shelf and mounting plate.
6. Replace the previously removed covers.

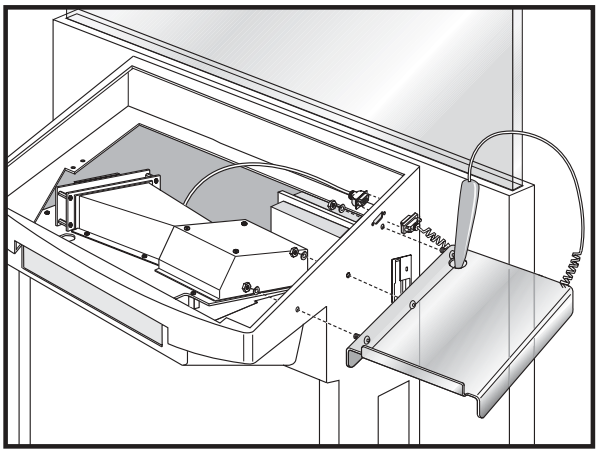


Figure 2-7: Installing the Bar Code Reader

3.0 M-IV Interconnections

The following procedures detail making the connections between the Gantry and the Operator Console and how to connect the unit to power. Refer to Figure 2-8 throughout the following.

3.1 Interconnections—Gantry to Console

1. At the rear of the remote console, connect one end of the power cable (Item 1, Figure 2-8) to the "Power In" receptacle (Item 2, Figure 2-8) on the console connector panel.
2. At the rear of the Gantry, remove the lower rear gantry cover. Route the free end of the power cable by the pre-installed conduits / wire-runs to the Gantry. Fasten the power cable connector to the "J2 Console Power" receptacle (Item 3, Figure 2-8) on the Gantry connector panel.
3. Connect one end of the data cable (Item 4, Figure 2-8) to the "Host to Micro Comm" receptacle (Item 5, Figure 2-8) on the console connector panel.
4. Route the free end of the data cable by the pre-installed conduits / wire-runs to the Gantry. Fasten the data cable connector to the "J1 Console Data" receptacle (Item 6, Figure 2-8) on the Gantry connector panel.
5. Fasten the data and power cable ground wires (4 wires, Item 7, Figure 2-8) and the Gantry to Console ground wire to the appropriate ground studs (Items 8 and 9, Figure 2-8).
6. For systems with the optional Label Printer, connect the printer's data cable connector to the "Printer" parallel port (Item 10, Figure 2-8) on the Console connector panel. Connect the printer power cable to local power.
7. For systems with optional DSM, connect the DSM data cable connector to the "DSM" port (Item 11, Figure 2-8) on the console connector panel. Connect the DSM power cable to local power.
8. Install the cable cover (set aside during radiation shied installation procedures) on the base of the Operator Console.

Legend for Figure 2-8

1. Power Cable
2. Power In receptacle
3. J2 Console Power receptacle
4. Data Cable
5. Host to Micro Comm receptacle
6. J1 Console Data receptacle
7. Data and Power Cable Ground Wires (Qty 4)
8. Ground Stud
9. Ground Stud
10. Printer Parallel Port
11. DSM Port
12. Isolation Transformer
13. Input Power Terminal Block
14. Input Power Cord
15. Ground Wire

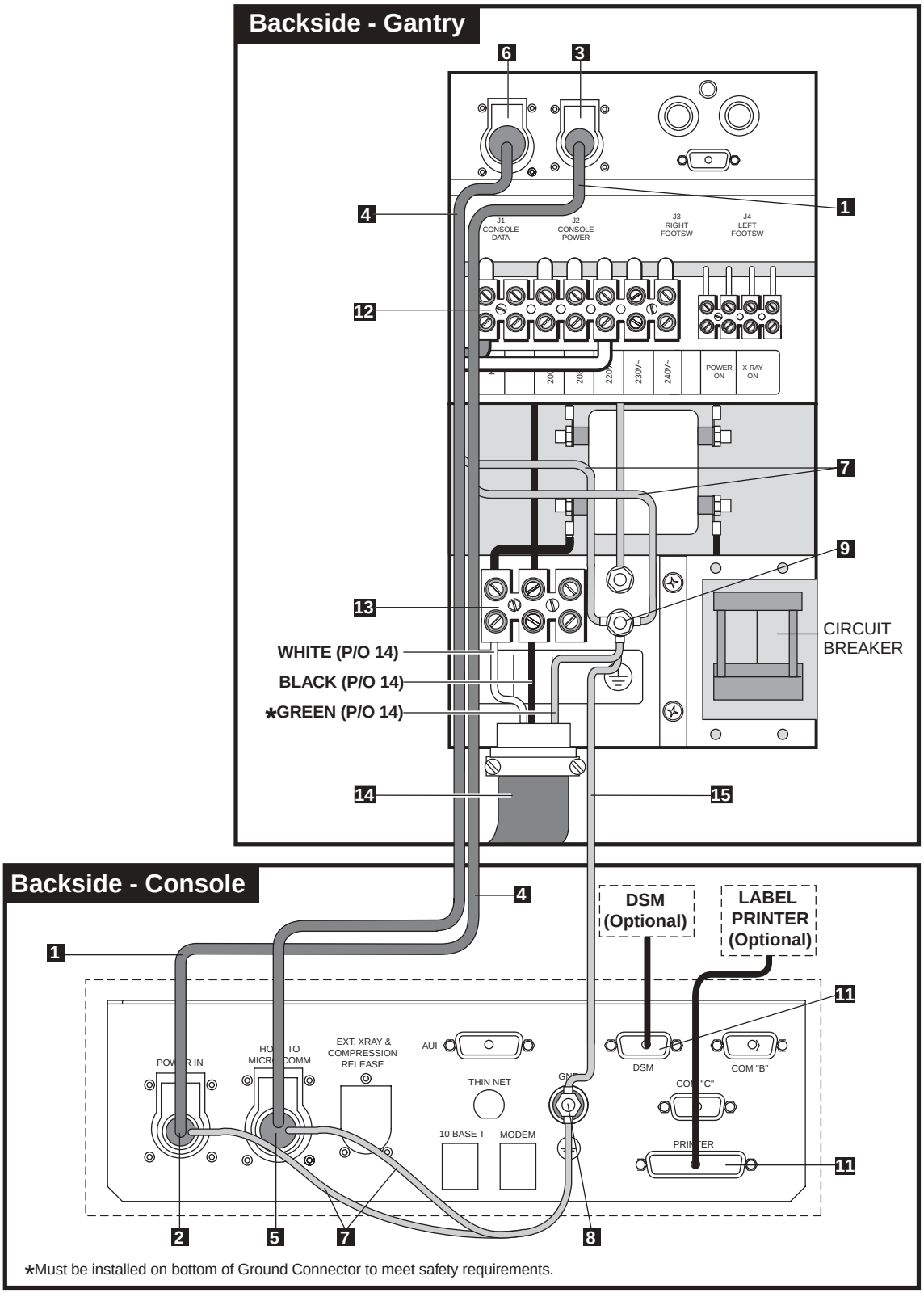


Figure 2-8: Unit Interconnections

3.2 Connecting to Power

The M-IV isolation transformer must be configured to match the power source at the site. This portion of the manual details the steps to properly configure and connect the mammography unit to a voltage source. Before connecting the unit to a mains disconnect, perform the following:

1. Measure the voltage at the mains disconnect.
2. Inquire as to any history of voltage fluctuations of voltage-related problems that have occurred in other equipment at the site.

After determining the input voltage range, verify that unit's isolation transformer tap (Item 12, Figure 2-8) is correctly set, or re-configure the transformer taps as required by performing the following:

Note…The mammography unit's isolation transformer is configured at the factory to match the voltage specified at the time the unit was ordered.

3. Make sure the unit is OFF and that the input power cord is detached from the mains.
4. Remove the Gantry's lower rear panel to access the input power terminal block.
5. Verify the isolation transformer taps are wired to match the previously measured source voltage, if not, configure the isolation transformer input wiring and tap as shown in Figure 2-9.
6. Verify that the line impedance does not exceed 0.16 ohms (200 V line), or 0.2 ohms for all other input voltages (208 V, 220 V, 230 V, or 240 V).

Note…The above requirements are met if the unit is operated on a line with no greater than 3% voltage drop under maximum operating load (Large Focal Spot @ 32 kV). Exceeding this requirement necessitates corrective action by the site.

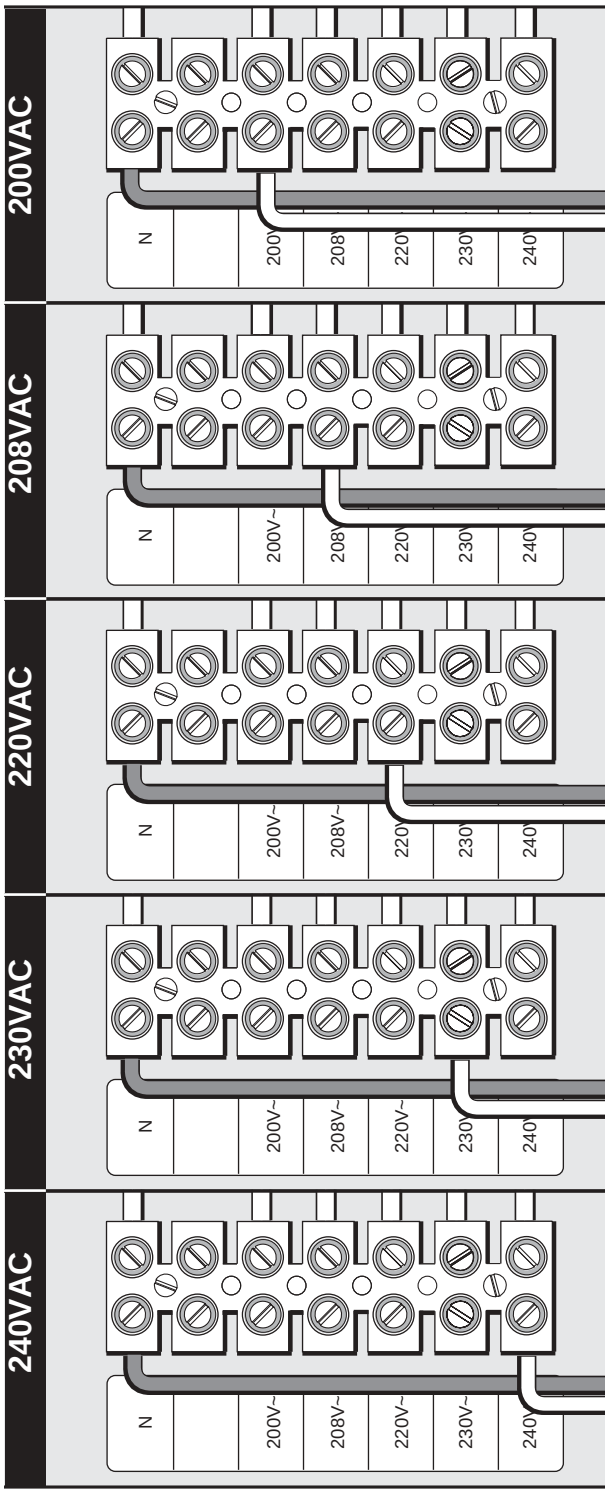


Figure 2-9: Input Power Configuration

Perform the following to attach the system to a source of power.

1. Connect the input power cord (Item 14, Figure 2-8) to the input power terminal block (Item 13, Figure 2-8) on the rear of the Gantry. Refer to Figure 2-10.
2. Permanently wire the opposite end of the input power cord to a disconnect panel.
3. Replace the lower rear Gantry cover.

CAUTION!

The connection of the protective earth terminal is critical to the safety of the operator and the patient. ALWAYS ensure that this connection is made prior to replacing the rear panel. Under no circumstances should this equipment be operated with the protective earth connector not in place.

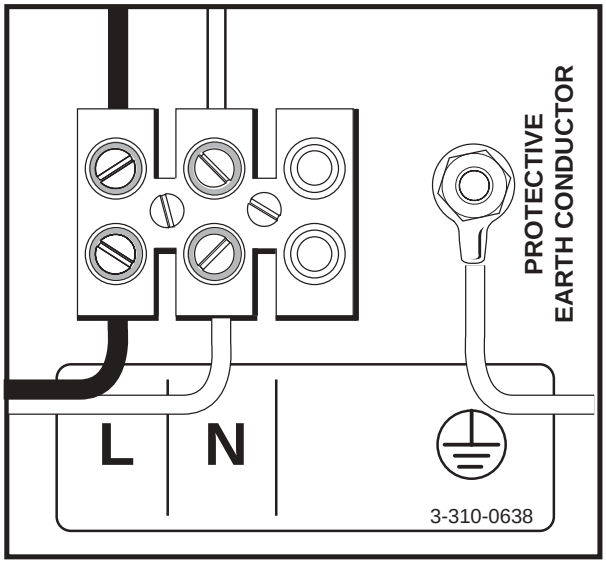


Figure 2-10: Connecting to Source

4.0 System Power Up

For normal operation, always perform the following checks prior to applying power to the M-IV:

- Check that the primary (source) power circuit breaker is ON.
- Check that the M-IV circuit breaker, on the back of the Gantry, is ON.
- Verify that ALL Emergency OFF Switches (two on the Gantry, one on the Console) are in the RESET position.

When complete, follow the start-up sequence below to power up the system.

1. On the Operator Console, press the ON button to apply power.
2. The system performs a series of checks of the internal subsystems. During this time, the remote microprocessors activate, and report to the Host microprocessor.

During boot up, the current software versions will be displayed on the bottom of the screen (will stay on screen for approximately 10 seconds. To freeze view, press shift + view at same time, repeat to un-freeze view.)

Failure of a subsystem to report causes an error condition. To hold the start-up sequence so that the error message remains on the screen, press the SHIFT and VIEW keys. To resume, press the SHIFT and VIEW keys again.

3. If, during the diagnostic checks, the system detects a fault or error condition, a message appears in the Message Area.
4. After the self-diagnostic checks, the display screen shows the Run Mode, and the start-up sequence is complete.

Note …After turning on the system, a tone will sound, and the Operator Console display will illuminate. These associated indicating devices indicate that system power is applied.

Chapter 3: System Setup

1.0 Switches and Connections

The Remote Console Operator Interface Microprocessor Board contains one DIP Switch (S1). Refer to Chapter 6: Operator Console Maintenance, Figure 6-1 for board location within the Remote Console.

The Host Microprocessor Board contains a Rotary Selection switch (S4), four push-button switches (S1, S2, S3, and S5), a Calibration Mode DIP Switch (S6), a Default DIP Switch (S7), and an LED display. Refer to Chapter 7: Gantry Maintenance, Figure 7-1 for board location within the Gantry. The tables that follow detail M-IV switch and jumper configurations. Refer to Figure 3-1 for switch identification and location on the Host Microprocessor Board.

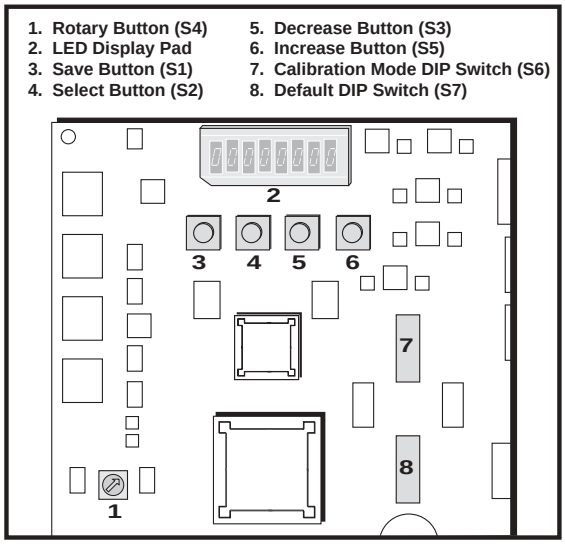


Figure 3-1: Host Microprocessor Switches

1.1 Remote Console Switch Settings

1.1.1 Operator Microprocessor Board DIP Switches

Table 3-1 identifies the Remote Console Operator Microprocessor Board DIP switch (S1) functions:

Table 3-1: Remote Console Operator Microprocessor Board DIP Switch (S1)

SWITCH	ON FUNCTION	OFF FUNCTION
1	Reverse Video	Normal Video
2	LCD Display	EL Display
3	DD/MM/YYYY Date format	MM/DD/YYYY Date format
4	Not Used	Test Screen
5	ID & Name Required For “Ready”	No ID & Name Required for “Ready”
6	Floppy Disk Drive Installed	No Floppy Disk Drive Installed
7	Check Floppy upon Run Screen Access	Skip Floppy check upon Run Screen Access
8	Not Used	Load Defaults on Power Up <Shift> + <Clear>

1.2 Host Microprocessor Board Switch Settings

1.2.1 Host Push-buttons (S1, S2, S3, S5)

Use the four push-buttons, S1, S2, S3, S5 (Items 3 through 6, Figure 3-1) below the LCD Display (Item 2, Figure 3-1) to switch among the variables for the selected calibration, to increase or decrease the displayed variables, and to save the changed information (see Table 3-2).

Table 3-2: Host Push-buttons

SWITCH	FUNCTION
S1	Save
S2	Select
S3	Decrease
S5	Increase

1.2.2 Calibration Mode DIP Switch (S6) Settings

Prior to calibrating any system parameter, it will be necessary to first set the appropriate switches on the Calibration Mode Dip Switch, S6 (Item 7, Figure 3-1) as shown below:

Table 3-3: Calibration Mode DIP Switch (S6)

SWITCH	STATUS	FUNCTION
1	see below	Peripheral Monitor (KJ26) Select
2	see below	Peripheral Monitor (KJ26) Select
3	ON	Load TOSHIBA defaults
	OFF	Load VARIAN defaults
4	ON	Calibration Mode
	OFF*	Run Mode
5	OFF	NOT USED
6	ON	5 second STANDBY after x-ray
	OFF*	30 second STANDBY after x-ray
7	ON	Host Alarm Enabled
	OFF*	Host Alarm Disabled
8	ON	Alternate S4 function 1 **
	OFF*	Alternate S4 function 2 **

S6-1/S6-2 SWITCH SETTING	PERIPHERAL (Monitored at KJ26)
OFF/OFF	Tubehead
OFF/ON	Generator
ON/OFF	Motor
ON/ON	Image Receptor

*Normal Operating Position

**Refer to Table 3-4, Rotary Switch (S4) Settings

1.2.3 Rotary Switch (S4) Settings

The Rotary Selection switch, S4 (Item 1, Figure 3-1) is a 16 position switch numbered 0 through 9, and A through F. Each switch position selects a calibration parameter (see Table 3-4). The LCD display (Item 2, Figure 3-1) will show the selected calibration parameter.

Table 3-4: Rotary Switch (S4) Settings

S4 POSITION	S6, 8 POSITION	FUNCTION / CALIBRATION
0	ON	Exposure Counter
	OFF	kV & Mode Display
1	ON	Tube Type Select (Varian 0, Varian 1, Toshiba)
	OFF	mAs (manual); mAs Window (auto modes)
2	ON	HTC Thickness Threshold
	OFF	Filament Preheat Calibration
3	ON	Not Used
	OFF	Density, Filter, Spot Size Display
4	ON	HTC AKV Filament Calibration - 2nd Sample Exposure
	OFF	Tube Grid Bias Calibration
5	ON	Rotation & Vertical Speed Control & Force Load Cell Select
	OFF	Calibration - Compression Height & Force, C-arm Angle
6	ON	Auto-Filter kV Threshold and Offset
	OFF	Compression Force Limits Calibration
7	ON	Compression Release Distance
	OFF	Compression Force & Release Mode Display
8	ON	Not Used
	OFF	Small Focal Spot Collimator Calibration
9	ON	Software Version Display
	OFF	M3-Style Bucky Calibration
A	ON	Not Used
	OFF	Host Status - Error Codes
B	ON	Image Receptor Detector Voltages
	OFF	I.R. Accessory & Paddle Accessory Display
C	ON	Not Used
	OFF	Mirror Position Calibration
D	ON	Not Used
	OFF	Filter Position Calibration
E	ON	AEC Detector Gain Cal. & HTC Reduced mA Cal. Factor
	OFF	AEC Calibration (Gain, Offset, Mean)
F	ON	Not Used
	OFF	Collimator Position Calibration (aperture, blade, position)

1.2.4 Default DIP Switch (S7) Settings

Various states, foreign communities, and individual sites have instituted the 2 mGy (200 mrad) maximum average glandular dose requirement. The M-IV meets these requirements by providing switch enabled options. Prior to releasing the unit for use, the 200 mrad operating requirements must be set via the Default DIP Switch, S7 (Item 8, Figure 3-1) as shown in Table 3-5.

Note…The 200 mrad window is most effective when the screen-film speed is 170 or less. It is generally not necessary to use the 200 mrad window when the screen-film speed is greater than 170. Please consult your Medical Physicist regarding screen-film combinations and the 200 mrad window for specific recommendations.

Note…System restart is required for switch setting changes to take effect.

Table 3-5: Default DIP Switch (S7) Settings

SWITCH	STATUS	FUNCTION
1	ON	Power Aid (.5 sec delay)
	*OFF	Normal
2	---	NOT USED
3	---	NOT USED
4	---	NOT USED
5	---	NOT USED
6	see below	Auto-kV Window Options
7	see below	Auto-kV Window Options
8	ON	DSM HV Enable (does not include boost)
	OFF	DSM HV Enable (includes boost)

SWITCH SETTING		Auto-kV Window Options
S7-6	S7-7	
ON	OFF	**Auto Windows only enabled
OFF	ON	***Manual Windows only enabled
OFF	OFF	****Manual Windows and Auto Windows enabled

*Normal Operating Position

**For sites which must meet the 200 mrad maximum average glandular dose requirement (due to either regulations or site preference) and who do not have the option of selecting manual timing window (125, 165, and 200 mAs Large Spot, and 38, 50, and 60 mAs Small Spot).

***For sites not required to meet the 200 mrad maximum average glandular dose requirement and who choose to only have the option of selecting the manual timing window (125, 165, and 200 mAs Large Spot, and 38, 50, and 60 mAs Small Spot).

****For sites not required to meet the 200 mrad maximum average glandular dose but which choose to provide the option of auto window or manual timing window selection (125, 165, and 200 mAs Large Spot, and 38, 50, and 60 mAs Small Spot).

1.2.5 Peripheral Monitor Ports

The M-IV permits the user to connect a computer, via serial port, to the Host Microprocessor. This permits the user to monitor various subsystem serial communication transfers. Use Table 3-4, "Rotary Switch (S4) Settings," as a guide when connecting the computer's serial port to the Host Microprocessor.

Note …The computer used to monitor the serial communication transfers must have terminal emulation (i.e., VTERM, ANSI, VT100, etc.). Set the computer's serial port as follows:

Baud	9600
Data Bits	8
Parity	NONE
Stop Bits	1
Flow Control	XON / XOFF

Table 3-6: Host Peripheral Ports

SERIAL CONNECTOR	SWITCH SETTING	PERIPHERAL
KJ17	N/A	Console X-ray (x-ray)
KJ16	N/A	Console (kV, mAs, etc.)
KJ13	N/A	NOT USED
KJ14	N/A	NOT USED
KJ15	S6 (4-ON, 8-OFF)	CAL Data Download
KJ26	S6 (1-OFF, 2-OFF)	Tubehead Motors
KJ26	S6 (1-ON, 2-OFF)	Generator
KJ26	S6 (1-OFF, 2-ON)	Motor Controls (C-arm up, down, rotation)
KJ26	S6 (1-ON, 2-ON)	Image Receptor (AEC, accessory detection)

2.0 Functional Checks—Mechanical

These functional checks ensure that the M-IV electromechanical systems are working properly. Refer to Figure 3-2, C-arm Controls, for location of C-arm and Tubehead controls.

2.1 Functional Checks—Compression System

The following steps check the function of the Compression Device drive motor and brake controls, and the compression force and thickness indicators. To complete this check, install a compression accessory, then place 4 cm of B.E.M. on the IRSD.

1. Press and hold a COMPRESSION DOWN button (Item 9, Figure 3-2) and verify the following:
   - Compression Device moves downward
   - Compression Thickness Display decreases
   - Collimator lamp illuminates for 30 seconds
   - Compression Force display increase upon compression of B.E.M.
   - Compression Device stops upon releasing key
   - Compression clutch brake engages
2. Press and hold a COMPRESSION UP button (Item 8, Figure 3-2) and verify the following:
   - Compression Device moves upward
   - Compression Thickness Display increases
   - Compression Force display decreases
   - Compression Device stops upon releasing key

Note …Repeat steps 1 and 2 using the attached Footswitches.

3. Press and release a COMPRESSION RELEASE button (Item 7, Figure 3-2) and verify the following:
   - Compression clutch brake disengages
   - Compression Device moves upward
   - Compression Thickness Display increases
   - Compression Force display decreases
   - Compression Device stops automatically

2.2 Functional Checks—C-arm Movement System

The following steps check for proper function of the C-arm movement motors and brakes, and the operation of the C-arm rotation indicators.

1. Press and hold a C-arm UP button (Item 5, Figure 3-2) and verify the following:
   - C-arm moves upward
   - C-arm stops automatically upon reaching travel limit
2. Press and hold a C-arm DOWN button (Item 6, Figure 3-2) and verify the following:
   - C-arm move downward
   - C-arm stops automatically upon reaching travel limit

Note …Repeat steps 1 and 2 using the attached Footswitches.

3. Press and hold a counterclockwise C-arm ROTATION button (Item 3, Figure 3-2) and verify the following:
   - C-arm rotates counterclockwise (as viewed from the front)
   - Rotation speed gradually increases
   - C-arm stops automatically upon reaching -150°
4. Press and hold a clockwise C-arm ROTATION button (Item 2, Figure 3-2) and verify the following:
   - C-arm rotates clockwise (as viewed from the front)
   - Rotation speed gradually increases
   - C-arm slows, then pauses momentarily at 0° before continuing
   - C-arm stops automatically upon reaching +195°

2.3 Functional Checks—Collimator Lamp Button

The following check verifies proper function of the Collimator Lamp, the Collimator Lamp buttons, and the Collimator Lamp logic circuitry.

1. Press a Collimator Lamp button (Item 4, Figure 3-2) and verify the following:
   - Collimator Lamp illuminates
   - Collimator Lamp automatically turns off after approximately 30 seconds

2.4 Functional Checks—Collimator Override Switch

The following check verifies proper function of the Collimator override button (Item 1, Figure 3-2).

1. Press the Collimator Lamp button.
2. Press the COLLIMATOR OVERRIDE button and verify the following:
   - 4-blade collimator device moves to another field size

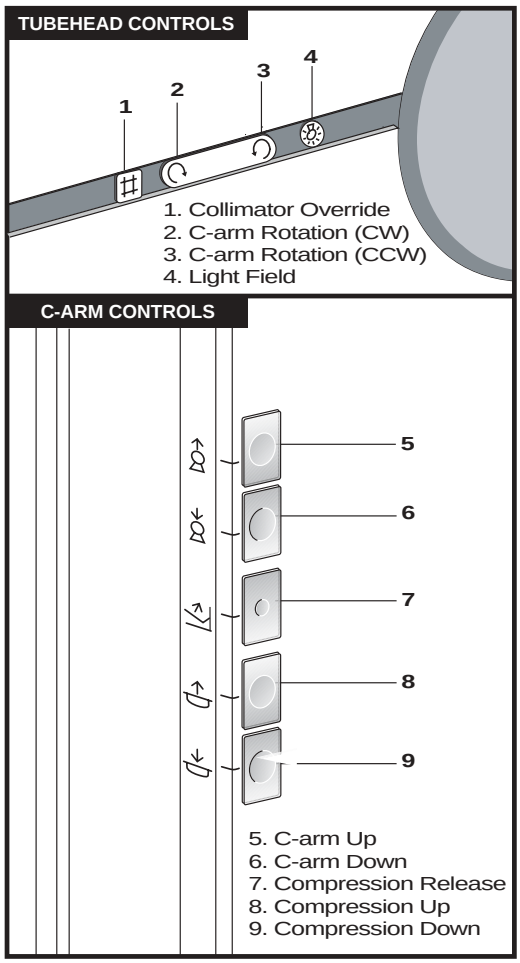


Figure 3-2: C-arm Controls

3.0 Setting System Defaults

The user can select system default settings for many system functions by entering the Setup Mode. The Changes made in the Setup Mode will define how the system is set each time power is turned on. This section of the manual describes how to set system functions and exposure parameters.

To enter the Setup Mode from the Run Mode, press the "Run/Setup" key. The M-IV Run Mode and Setup screens are shown in Figure 3-3. The locations of the Console keys are shown in Figure 3-4.

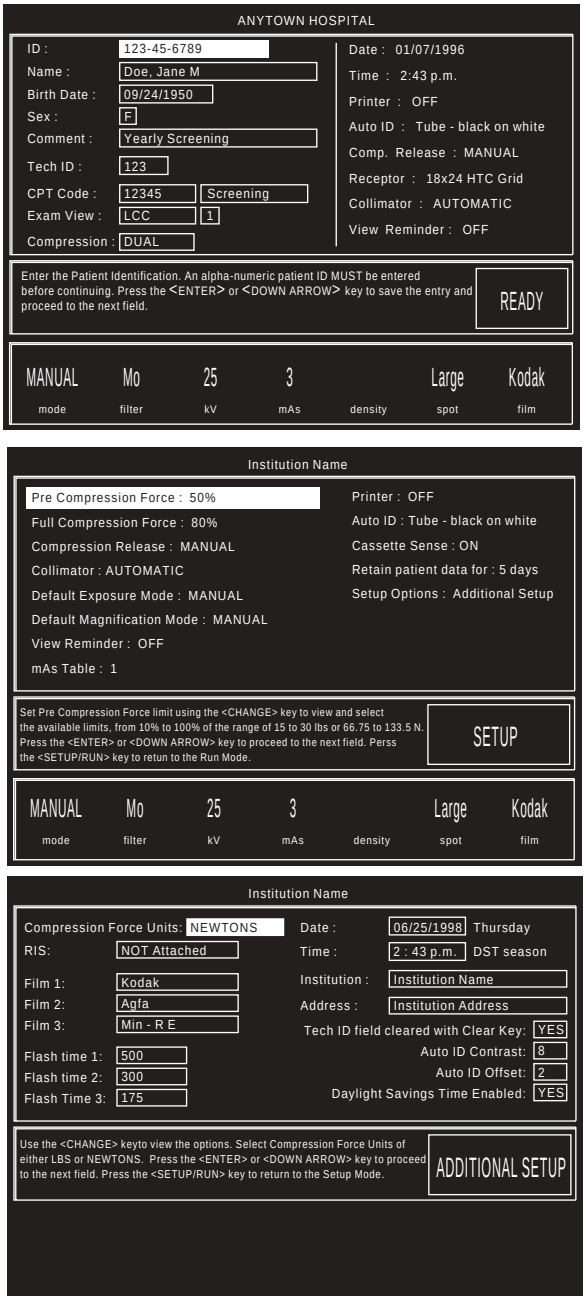

ANYTOWN HOSPITAL
ID : 123-45-6789
Name : Doe, Jane M
Birth Date : 09/24/1950
Sex : F
Comment : Yearly Screening
Tech ID : 123
CPT Code : 12345 Screening
Exam View : LCC 1
Compression : DUAL
Date : 01/07/1996
Time : 2:43 p.m.
Printer : OFF
Auto ID : Tube - black on white
Comp. Release : MANUAL
Receptor : 18x24 HTC Grid
Collimator : AUTOMATIC
View Reminder : OFF
Enter the Patient Identification. An alpha-numeric patient ID MUST be entered before continuing. Press the <ENTER> or <DOWN ARROW> key to save the entry and proceed to the next field.
READY
MANUAL Mo 25 3 Large Kodak
mode filter kV mAs density spot film
Institution Name
Pre Compression Force : 50%
Full Compression Force : 80%
Compression Release : MANUAL
Collimator : AUTOMATIC
Default Exposure Mode : MANUAL
Default Magnification Mode : MANUAL
View Reminder : OFF
mAs Table : 1
Printer : OFF
Auto ID : Tube - black on white
Cassette Sense : ON
Retain patient data for : 5 days
Setup Options : Additional Setup
Set Pre Compression Force limit using the <CHANGE> key to view and select the available limits, from 10% to 100% of the range of 15 to 30 lbs or 66.75 to 133.5 N. Press the <ENTER> or <DOWN ARROW> key to proceed to the next field. Perss the <SETUP/RUN> key to retun to the Run Mode.
SETUP
MANUAL Mo 25 3 Large Kodak
mode filter kV mAs density spot film
Institution Name
Compression Force Units: NEWTONS
RIS: NOT Attached
Film 1: Kodak
Film 2: Agfa
Film 3: Min - R E
Flash time 1: 500
Flash time 2: 300
Flash Time 3: 175
Date : 06/25/1998 Thursday
Time : 2 : 43 p.m. DST season
Institution : Institution Name
Address : Institution Address
Tech ID field cleared with Clear Key: YES
Auto ID Contrast: 8
Auto ID Offset: 2
Daylight Savings Time Enabled: YES
Use the <CHANGE> keyto view the options. Select Compression Force Units of either LBS or NEWTONS. Press the <ENTER> or <DOWN ARROW> key to proceed to the next field. Press the <SETUP/RUN> key to return to the Setup Mode.
ADDITIONAL SETUP

Figure 3-3: The M-IV Screens

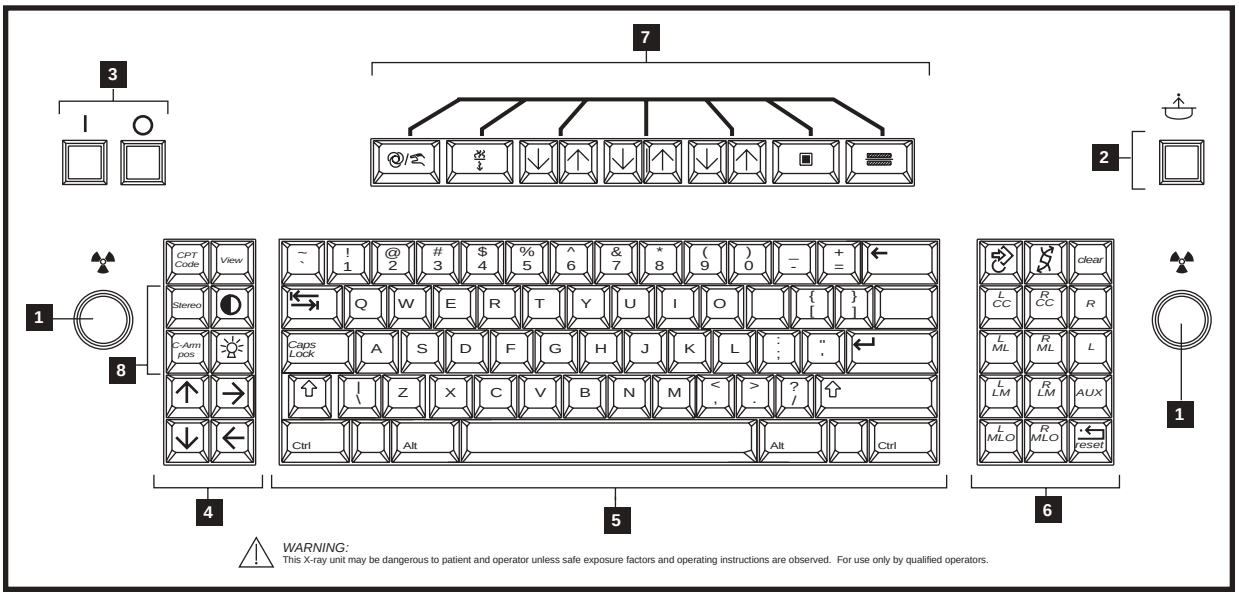


Figure 3-4: Operator Console Keyboard

Figure 3-4 Legend.

1. X-ray Exposure Switch (2)
2. Compression Release Switch
3. Power ON and OFF Switches
4. Function Keypad
5. Alphanumeric Keypad
6. View Keypad
7. Exposure Technique Keypad
8. StereoLoc II Option Keys (not present on units without LORAD StereoLoc II option).

3.1 Making Selections / Entering Data

Select data fields by moving the on-screen highlight bar to the data field requiring change. The M-IV permits several methods of selecting, or highlighting the data fields. Use the ARROW keys, on the Function Keypad, to move the highlight bar up, down, left or right on the screen. The highlight bar also advances to the next data field by pressing the ENTER key, or by pressing TAB. Note, however, that some entries are not complete (recorded) until the ENTER key is pressed.

Note …There are some data fields in the RUN MODE that require an entry before the highlight can be moved from that field.

Once a data field is selected (highlighted), the required data is either manually entered using the alphanumeric keys (i.e., ID, NAME, etc.), or selected from the available choices using the CHANGE key (i.e., COMPRESSION data field). Also, the CPT CODE key and the VIEW key change the selection for their corresponding data fields (CPT CODE and EXAM VIEW). Exposure techniques are selected using the corresponding Exposure Technique select keys.

3.2 The Default Worksheet

Use the Default Worksheets (Tables 3-7, 3-8, and 3-9) to record the system defaults and the exposure techniques typically used by the customer. Inquire as to the users preferences prior to making changes in the Setup Mode. This worksheet also provides an area for recording label information (i.e., Institution name and Film Type, etc.).

Table 3-7: Setup Mode Default Worksheet

Data Field	Available Choices	User Preference
Pre Compression Force	10% - 100% (15lbs - 30lbs)	
Full Compression Force	10% - 100% (20lbs - 40lbs)	
Compression Release	Manual, Automatic	
Collimator	Manual, Automatic	
Default Exposure Mode	Manual, Auto-Time, Auto kV, Auto Filter	
Default Magnification Mode	Manual, Auto-Time, Auto kV	
View Reminder	On, Off	
mAs Table (manual & mag manual modes)	1 (coarse) 2 (fine)	
Printer	ON or OFF	
Auto ID	Tube Side (black on white); Emulsion Side (black on white); Tube Side (white on black); Emulsion Side (white on black); OFF	
Cassette Sense	ON or OFF	
Retain Patient Data for	1 Day, 2 Days, 3 Days, 4 Days, 5 Days	
Variable Speed Compression	1% Steps in range of 00% to 90%	
Density Step	6%, 8%, 10% and 12.5%	

Table 3-8: Additional Setup Mode Default Worksheet

Data Field	Available Choices	User Preference
Compression Force Units	NEWTONS or LBS (pounds)	
RIS	ATTACHED or NOT ATTACHED	
Film 1	1st Film Label	
Film 2	2nd Film Label	
Film 3	3rd Film Label	
Flash Time 1	Flash Time for Film 1 (1 to 9999)	
Flash Time 2	Flash Time for Film 2 (1 to 9999)	
Flash Time 3	Flash Time for Film 3 (1 to 9999)	
Date	MM/DD/YYYY (USA Format) DD/MM/YYYY (International Format)	
Time	HH:MM:AM/PM (12-Hour Format) HH:MM (24-Hour Format)	
Institution	Up to 32 Characters*	
Address	Up to 32 Characters	
Tech ID field cleared w/Clear Key	YES or NO	
Auto ID Contrast	Contrast Adjustment of Film Label (1 to 19)	
Auto ID Offset	Film Label Placement Adjust (0 to 7)	
Daylight Savings Time	YES or NO	

*Last character denotes Unit Number.

Table 3-9: Exposure Technique Default Worksheet

Technique	Manual	Auto-Time	Auto-kV	Auto Filter
Filter	❑ Molybdenum (Mo) ❑ Rhodium	❑ Molybdenum (Mo) ❑ Rhodium	❑ Molybdenum (Mo) ❑ Rhodium	Not Selectable (default is Mo)
kV	❑ 20 - 35 kV- (Mo) ❑ 28 - 39 kV- (Rh)	❑ 20 - 35 kV- (Mo) ❑ 28 - 39 kV- (Rh)	❑ 25 - 26 kV (Mo) * ❑ 28 kV (Rh)	❑ 25 - 26 kV *
mAs	❑ Table 1 (3mAs-500mAs, 23 steps) ❑ Table 2 (3mAs-500mAs, 59 steps)	Not Selectable	Not Selectable	Not Selectable
Density	Not Selectable	❑ -5 to 0 to +5	❑ -5 to 0 to +5	❑ -5 to 0 to +5
Spot	❑ Large ❑ Small	❑ Large ❑ Small	❑ Large ❑ Small	❑ Large
Film	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3
Auto-kV Window	Not Selectable	Not Selectable	LARGE ❑ 125 mAs ❑ 165 mAs ❑ 200 mAs ❑ Auto SMALL ❑ 38 mAs ❑ 50 mAs ❑ 60 mAs ❑ Auto	LARGE ❑ 200 mAs ❑ Auto

Technique	Mag Manual	Mag Auto-Time	Mag Auto-kV	
Filter	❑ Molybdenum (Mo) ❑ Rhodium	❑ Molybdenum (Mo) ❑ Rhodium	❑ Molybdenum (Mo) ❑ Rhodium	
kV	❑ 20 - 35 kV- (Mo) ❑ 28 - 39 kV- (Rh)	❑ 20 - 35 kV- (Mo) ❑ 28 - 39 kV- (Rh)	❑ 25 - 26 kV (Mo) * ❑ 28 kV (Rh)	
mAs	❑ Table 1 (3 mAs-125 mAs, 17 steps) ❑ Table 2 (3 mAs-150 mAs, 41 steps)	Not Selectable	Not Selectable	
Density	Not Selectable	❑ -5 to 0 to +5	❑ -5 to 0 to +5	
Spot	❑ Small	❑ Small	❑ Small	
Film	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3	❑ Film Label 1 ❑ Film Label 2 ❑ Film Label 3	
Auto-kV Window	Not Selectable	Not Selectable	SMALL ❑ 38 mAs ❑ 50 mAs ❑ 60 mAs ❑ Auto	

* In these instances, and when the system is operating with an HTC Bucky, the kV is 25 kV only.

3.3 Setting Defaults—Setup Mode Screen

Use the following as a guide when setting system defaults to the user preferences previously recorded in (Tables 3-7, 3-8, and 3-9).

3.3.1 Default Setting—Pre-Compression Force

This data field permits selection of the motorized pre-compression force to the values in the chart below. The force setting selected here will also be the pre-compression force setting for the Dual Compression Force mode. The approximate Pre-Compression Forces available are listed below:

3.3.2 Default Setting—Full-Compression Force

This data field permits selection of the motorized full-range compression force to the values in the chart below. The force setting selected here will also be the full range compression force setting for the Dual Compression Force mode. The approximate Full Compression Forces available are listed in Table 3-10:

Table 3-10: Compression Force

% OF FORCE RANGE	PRE-COMPRESSION FORCE (LBS)	FULL COMPRESSION FORCE (N)	FULL COMPRESSION FORCE (LBS)	FULL COMPRESSION FORCE (N)
10	15	66.8	20	89
20	17	75.7	22	97.9
30	18.5	82.3	24.5	109
40	20	89	26.5	117.9
50	22	97.9	28.5	126.8
60	23.5	104.5	30.5	135.7
70	25	111.3	33	146.9
80	26.5	117.9	35	155.8
90	28	124.6	37.5	166.9
100	30	133.5	40	178

3.3.3 Default Settings—Compression Release Mode

The compression release function operates in one of two user selectable modes. The setting made here dictates which release mode the unit will be in when system power is first applied. The compression release modes are MANUAL and AUTOMATIC.

The Compression Release Distance is factory-set at 10 cm. However, this distance can be reset to 5 cm, 7.5 cm, or 12.5 cm.

3.3.4 Default Setting—Collimator Mode

The collimator device within the M-IV tubehead operates in one of two modes, MANUAL or AUTOMATIC.

When the Collimator Mode is set to AUTOMATIC, detection circuitry senses the size of the installed image receptor and Compression Paddle, then automatically adjusts the field size appropriately for application. When in automatic mode, field size can be reduced by pressing collimator override button, rear blade only will move.

When the Collimator Mode is set to MANUAL, detection circuitry only senses the size of the installed image receptor, and automatically limits the field size appropriately. All subsequent field size adjustments for the application are made using the Collimator Override Switch on the tubehead.

In either Collimator Mode, the maximum field size is always limited to the size of the installed image receptor.

Using standard screening paddles, regardless of mode selected, only the rear blade moves when collimator override switch is pressed. With any other available paddle, when in manual mode, the user can select any of the available field sizes.

3.3.5 Default Setting—Exposure Mode

The unit incorporates three automatic exposure modes, and one manual exposure mode. This default setting should be set to the exposure mode most often used, however, all three exposure modes are always available in the Run Mode to accommodate various applications. The available exposure modes for this data field are:

- MANUAL
- AUTO-TIME
- AUTO-KV
- AUTO-FILTER

3.3.6 Default Setting—Magnification Mode

This data field permits the user to select which one of the available exposure modes is automatically selected each time the Magnification Table is installed. The choices for this data field are:

- MANUAL
- AUTO-TIME
- AUTO-KV

3.3.7 Default Setting—View Reminder

The machine may be set so that exposures are not possible unless an exam view is set in the Run Mode. Typically, the view reminder is turned on for clinical examinations. However, the user may opt to switch it off to perform verification exposures (using a phantom), or a service technician may turn it off while calibrating the unit.

The only options for the View Reminder are ON or OFF.

3.3.8 Default Setting—Timing Windows / mAs Table

Manual exposures require that the user set a fixed mAs for exposure timing. Two mAs modes available (for exact mAs step values for both modes, refer to Table 3-9) are:

- Table 1 (coarse selection)
- Table 2 (fine selection)

For M-IV mammography systems, the selection of x-ray tube kV and filter combination in Auto-kV and Auto-Filter modes is determined by a pre-selected mAs window.

When the exposure mode is set to Auto-kV or Auto-Filter, this data line reads “Auto-kV Window” and the system determines the exposure factors necessary to make films at the optimum optical density, with ideal contrast. To do this, the user must set a timing “window” that determines when to terminate the exposure. In Auto-kV mode three manual (125, 165, and 200 mAs) and one automatic (200 mrad) timing window can be selected. In Auto-Filter mode, there is only one manually selectable window (200 mAs) available along with the automatic (200 mrad) window. The Auto-kV and Auto-Filter operation principles are to select a kV or kV/filter combination so that the final exposure in mAs will not exceed the pre-selected mAs window value.

3.3.8.1 Manual Timing Windows

The Auto-kV manual timing window selections vary depending on the whether Large or Small Spot is selected. The Large Spot manual timing window choices are 125, 165 and 200 mAs, the Small Spot timing window choices are 38, 50 and 60 mAs. When one of the manual timing windows is set (for Auto-kV or Auto-Filter Modes), the system terminates an exposure using the following criteria:

Priority #1: The first priority of the system is to ensure optimum optical density on the developed film. If necessary (to meet the optical density requirement), the system increments the kV to its maximum, and surpasses the set timing "window".

Priority #2: When the system determines that the optical density requirement can be met, it attempts to maximize contrast by terminating the exposure as near the set timing "window" as possible (less than or equal to, should not exceed). This, however, must be achieved while still maintaining the optical density requirements.

Priority #3: The third priority of the system is to reduce patient dose. This is done by maintaining the starting kV level, or by incrementing the kV to a level less than the maximum. Reduction of patient dose, however, must not compromise the optical density and/or the contrast requirements.

3.3.8.2 Auto Timing Window

The auto timing window (based on breast thickness) should be selected by those users who are required to meet the 2 mGy (200 mrad) maximum average glandular dose requirement.

The auto timing window is calculated by the M-IV during the exposure. When the Auto timing window is selected the final kV or kV/filter combination is determined as follows:

If breast thickness (T) is < 4.5 cm,
mAs window = 60;
maximum kV = 28;

Else (if T > 4.5 cm),
mAs window = 165;
minimum kV = 28;
maximum kV = 30 for Auto-kV;
maximum kV = 32 for Auto-Filter

In practice, the kV selected for exposing the standard breast phantom will be between 27 and 28 kV depending on the desired film density. The corresponding average glandular dose will be less than 2 mGy (200 mrad).

3.3.9 Default Setting—Printer

To print hard copy labels of patient information and exposure factors, the optional printer must be installed, and the Printer data field (in the Setup Mode) must be set ON.

The user selectable choices for the Printer data field are ON or OFF.

3.3.10 Default Setting—Auto ID

The system is equipped with the AutoFilm ID which places a photographic label of exposure techniques and identification data on the film. The AutoFilm ID requires the use of DIN-style cassettes with the built-in sliding window. The user selectable choices for the Auto ID data field are:

- Tube Side - black on white
- Tube Side - white on black
- Emulsion Side - black on white
- Emulsion Side - white on black
- OFF

3.3.11 Default Setting—Cassette Sense

The Cassette Sense Interlock works with the M-IV style Bucky Device or the Magnification Table only. This data field permits the user to choose the Cassette Sense Interlock status as ON or OFF.

When the interlock is ON, the M-IV prevents an exposure when a cassette is not inserted into the Bucky device, or when the cassette has not been ejected and then replaced after an exposure. When the interlock is OFF, exposures are not inhibited.

3.3.12 Default Setting—Retain Patient Data

This data field permits the user to choose the length of time the M-IV will store pre-scheduled information on the dynamic RAM located on the Remote Console Microprocessor Board. The choices for this data field are 1, 2, 3, 4, or 5 Days.

3.3.13 Default Setting—Variable Speed Compression

The Variable Speed Compression Feature establishes the rate at which the compression device moves down and can be adjusted in 10% steps, displayed in the range of 00% to 90%. Set compression speed default as follows:

1. Open M-IV Gantry right door.
2. On the Host board, set S6 switch 4 (Item 7, Figure 3-1) to ON to enable calibration.
3. Rotate S4 (Item 1, Figure 3-1) to position 5 and set S6 switch 8 to ON.
4. Press S2 (Item 4, Figure 3-1) twice to display the compression speed calibration on the LED display pad (Item 2, Figure 3-1).
5. Verify that the displayed speed can be adjusted in 10% steps using S3 to increase and S5 to decrease (Items 5 and 6, Figure 3-1).
6. Set the compression speed default to 80% using S3 and S5 as necessary.
7. Press S1 (Item 3, Figure 3-1) to save compression speed default.
8. Set S6 switch 4 to OFF to disable calibration.

3.3.14 Default Setting—Density Step

Front panel density steps (6%, 8%, 10% and 12.5%) can be selected. The default selection is 10%. Set the density step default as follows:

1. Open M-IV Gantry right door.
2. On the Host board, set S6 switch 4 (Item 7, Figure 3-1) to ON to enable calibration.
3. Rotate S4 (Item 1, Figure 3-1) to position 3 and set S6 switch 8 to ON to display the density step on the LED display pad (Item 2, Figure 3-1).
4. Set density step to desired percent using S3 to increase and S5 to decrease (Items 5 and 6, Figure 3-1).
5. Set S6 switch 4 to OFF to disable calibration.

3.4 Default Settings - Additional Setup Mode Screen

The Additional Setup Mode is a second setup screen which permits setting the interface, entering system labels, and changing the time and date. To access the Additional Setup mode screen, perform the following:

1. Highlight the Setup Options data field.
2. Press the Change key until Additional Setup appears in the data field. Press the Enter key to switch screens.

3.4.1 Default Setting—Compression Force Units

Use this data field to set the method with which the system displays the compression force units of measure. The two choices are NEWTONS or LBS (Pounds).

3.4.2 Default Setting—RIS

This data field sets the system for use with the Hospital or Clinic Radiographic Information System (RIS). The options for this data field are ATTACHED or NOT ATTACHED.

3.4.3 Setting—Film 1

Use this data field to type in the name of the first screen-film combination to appear as a choice in the Film Type data field in the Run Mode. To enter a film type, follow the steps below. Note that film type entry is the same for all three film type data fields.

1. Highlight the Film 1 data field.
2. Film fields must be backspaced to clear old screen-film information. Type the name of the screen-film combination, then press Enter.

Note…The 200 mrad window is most effective when the screen-film speed is 170 or less. It is generally not necessary to use the 200 mrad window when the screen-film speed is greater than 170. Please consult your Medical Physicist regarding screen-film combinations and the 200 mrad window for specific recommendations.

3.4.4 Setting—Film 2

Use this data field to type in the name of the second screen-film combination to appear as a choice in the Film Type data field in the Run Mode. Film fields must be backspaced to clear old screen-film information.

3.4.5 Setting—Film 3

Use this data field to type in the name of the third screen-film combination to appear as a choice in the Film Type data field in the Run Mode. Film fields must be backspaced to clear old screen-film information.

3.4.6 Setting—Flash Time 1

Use this data field to type in the length of time that the AutoFilm ID flashes for film type #1. The value entered here represents time in milliseconds. This data field holds up to four digits and must be in the range of 1 to 9999 (500 is the default). To enter a flash time, perform the following:

1. Highlight the Flash Time 1 data field.
2. Flash Time fields must be backspaced to clear old screen-film information. Type the desired value (1 to 9999) for film type #1, then press Enter to record the value.

3.4.7 Setting—Flash Time 2

Use this data field to type in the length of time that the AutoFilm ID flashes for film type #2. The entry procedure is the same for all three Flash Times. Flash Time fields must be backspaced to clear old screen-film information.

3.4.8 Setting—Flash Time 3

Use this data field to type in the length of time that the AutoFilm ID flashes for film type #3. The entry procedure is the same for all three Flash Times. Flash Time fields must be backspaced to clear old screen-film information.

3.4.9 Setting—Date

Use this field to change the date display which appears in the Run Mode. The date format depends on the DIP Switch setting on the Microprocessor Board:

- DIP S1 switch 3 = OFF: MM/DD/YYYY (USA format)
- DIP S1 switch 3 = ON: DD/MM/YYYY (International format)

1. Highlight the Date data field, then use the Backspace key to delete the displayed date.
2. Type in the new date in the selected format (shown above).
3. Press Enter to complete the change.

Note …The day of the week will show to the right of the Date data field.

3.4.10 Setting—Time

Use this data field to change the time display which appears in the Run Mode. The format of the time display is selectable:

- HH:MM:AM/PM (12-hour format)
- HH:MM (24-hour format)

1. Highlight the Time data field, then press Change to select the desired format.
2. Use the backspace key to delete the displayed time, then type in the new time in the proper format (shown above).
3. Press Enter to complete the change.

Note…The label "DST season" appears next to the Time data field during the daylight savings time season.

3.4.11 Setting—Institution Data Field

The Institution's name displays in the space at the top of each Mode Screen, and is part of the AutoFilm ID label. The Institution data field permits entry of up to 32 characters to identify the name of the host institution. Use the Institution data field to enter or change the name of the institution, clinic, or hospital. Institution Data field must be backspaced to clear old screen-film information.

3.4.12 Setting—Address Data Field

The Address data field permits entry of up to 32 characters to identify the address of the host institution. This data is also part of the AutoFilm ID label. Use the Address data field to enter or change the address of the institution, clinic, or hospital. Address Data field must be backspaced to clear old screen-film information.

3.4.13 Setting—Tech ID Cleared with Clear Key

This data field permits the user to set the Clear Key so that is also removes the data from the Tech ID field when it is pressed. The choices for this data field are Yes or No.

3.4.14 Setting—Auto ID Contrast

Use this data field to change the contrast of the AutoFilm ID data when it is flashed onto the film. Lower values decrease contrast, while higher values increase contrast:

1. Highlight the data field.
2. Enter the desired value (between 1 and 19), then press Enter to record the change.

3.4.15 Setting—Auto ID Offset

Use this data field to adjust the distance from the edge of the film that the AutoFilm ID flashes the label. Higher values move the label farther from the edge, while lower values move it closer to the edge.

1. Highlight the data field.
2. Enter the desired value (between 0 and 7), then press Enter to record the change.

3.4.16 Setting—Daylight Savings Time

Use this data field to permit the system to automatically adjust the time display for the daylight savings time season. The only choices for this field are YES or NO.

3.4.17 Default Settings - Exposure Techniques

Use the area along the bottom of the screen to define the exposure parameters that will appear as defaults in the Run Mode's Exposure Technique Window. A unique set of parameters may be chosen for each exposure mode. Table 3-11 details the exposure parameters available for each exposure mode:

Table 3-11: Exposure Mode Parameter Matrix

MODE	TECHNIQUE	PARAMETER
MANUAL	**Filter**	**Molybdenum (Mo) or Rhodium (Rh)**
	kV	20kV - 35kV (Mo)
		28kV - 39kV (Rh)
	mAs Table	1 (3mAs - 500mAs, 23 steps)
		2 (3mAs - 500mAs, 59 steps)
	Density	not selectable
	Spot	Large or Small
	Film	1 of 3 film/screen combinations calibrated
AUTO TIME	**Filter**	**Molybdenum (Mo) or Rhodium (Rh)**
	kV	20kV - 35kV (Mo)
		28kV - 39kV (Rh)
	mAs Table	not selectable
	Density	-5 to 0 to +5
	Spot	Large or Small
	Film	1 of 3 film/screen combinations calibrated
AUTO KV	**Filter**	**Molybdenum (Mo) or Rhodium (Rh)**
	kV	25kV - 26kV (Mo)* or 28kV (Rh)
	mAs	not selectable
	Density	-5 to 0 to +5
	Spot	Large or Small
	Film	1 of 3 film/screen combinations calibrated
	Auto-kV Window	125mAs, 165mAs, 200mAs, Auto (Large)
		38mAs, 50mAs, 60mAs, Auto (Small)
AUTO FILTER	**Filter**	**not selectable (Mo is the starting default)**
	kV	25kV - 26kV *
	mAs Table	not selectable
	Density	-5 to 0 to +5
	Spot	Large
	Film	1 of 3 film/screen combinations calibrated
	Auto-kV Window	200mAs, Auto

*In these instances, and when the system is operating with an HTC Bucky, the default kV is 25 kV only.

Table 3-11: Exposure Mode Parameter Matrix (Continued)

MODE	TECHNIQUE	PARAMETER
MAG MANUAL	**Filter**	**Molybdenum (Mo) or Rhodium (Rh)**
	kV	20kV - 35kV (Mo)
		28kV - 39kV (Rh)
	mAs Table	1 (3mAs - 125mAs, 17 steps)
		2 (3mAs - 150mAs, 41 steps)
	Density	not selectable
	Spot	Small
	Film	1 of 3 film/screen combinations calibrated
MAG AUTO TIME	**Filter**	**Molybdenum (Mo) or Rhodium (Rh)**
	kV	20kV - 35kV (Mo)
		28kV - 39kV (Rh)
	mAs Table	not selectable
	Density	-5 to 0 to +5
	Spot	Small
	Film	1 of 3 film/screen combinations calibrated
MAG AUTO KV	**Filter**	**Molybdenum (Mo) or Rhodium (Rh)**
	kV	25kV - 26kV (Mo)* or 28kV (Rh)
	mAs Table	not selectable
	Density	-5 to 0 to +5
	Spot	Small
	Film	1 of 3 film/screen combinations calibrated
	Auto-kV Window	38mAs, 50mAs, 60mAs, Auto

*In these instances, and when the system is operating with an HTC Bucky, the default kV is 25 kV only.

4.0 Exposure System Calibration

Use the following section to setup, check, and calibrate the M-IV exposure generating system.

4.1 Line Regulation Check

1. Turn the system OFF. Place a true RMS AC voltmeter on L and N at the rear panel of the Gantry. Turn the system ON, then record the line voltage below:

   VNL = [ ]

2. Select 32 kV, 200 mAs, then make an exposure. Record the line voltage below:

   VL = [ ]

3. Calculate the line regulation (using the formula below). Verify that this value does not exceed 10%.

%REG = ([VNL -VL] / VNL) x 100% <10%

4.2 Setting—X-ray Tube Type

This procedure sets the Host for the type of x-ray tube installed. Perform this procedure as a preoperational check, or after replacing the x-ray tube.

1. Set the M-IV to the calibration mode (S6 switch 4 = ON). Set the Host Microprocessor for the X-ray Tube Selection mode (S4 to position 1; S6 switch 8 = ON).
2. Determine the type of x-ray tube installed on the M-IV (refer to x-ray tube's documentation). On the Host, press Select (S2) until the installed x-ray tube type appears (Varian 0, Varian 1, or Toshiba). The Varian tubes are identified by their labels on the cathode end of the tube housing.
3. Select "Varian 0" for Varian M113 and M113R x-ray tubes, refer to tube serial number and Table 3-12 if necessary. Select "Varian 1" for M113-1 and M113-1A Varian x-ray tubes.

Note …The last two digits of the tube serial number is the date code. The "alpha" digit indicates the month (see Table 3-11), the "numeric" digit indicate the year (i.e., -R7 = May 1997).

Table 3-12: X-Ray Tube Date Code Month Matrix

CODE	MONTH	CODE	MONTH	CODE	MONTH
N	JANUARY	R	MAY	V	SEPTEMBER
O	FEBRUARY	S	JUNE	W	OCTOBER
P	MARCH	T	JULY	X	NOVEMBER
Q	APRIL	U	AUGUST	Y	DECEMBER

4. Press (S1) to save the selection (the saved selection is displayed in capital letters). Set the Host for normal operation (S6 switch 4 = OFF).

4.3 Tube Bias Adjustment

This procedure sets the Tube Bias to the manufacturer's specification. The tube bias is set at the factory, or at the site after replacing the x-ray tube. BE SURE to select the proper x-ray tube (as determined by the previous procedure) BEFORE making the Tube Bias Adjustment.

1. Set the Host Microprocessor for the calibration mode (S6 switch 4 = ON).
2. Ensure the proper tube is selected (S4 to position 1; S6 switch 8 = ON) as per the previous procedure.
3. Set the Host Microprocessor for the Tube Bias adjustment (S4 to position 4; S6 switch 8 = OFF).
4. Obtain the Tube Bias value (voltage for Varian; resistance for Toshiba) from the manufacturers documentation for both focal spots.
5. Select the Large focal spot, then increase (S5) or decrease (S3) the displayed value according to the chart below.
6. Select the Small focal spot, then increase (S5) or decrease (S3) the displayed value according to the chart below.
7. When the appropriate Tube Bias is set, press Save (S1), then set the system to normal operation (S6 switch 4 = OFF).

Table 3-13: Tube Bias Voltage

VARIAN BOTH SPOTS	TOSHIBA SMALL SPOT	TOSHIBA LARGE SPOT
1 = 5V	0	100
2 = 5V	500	200
3 = 5V	1000	300
4 = 5V	1500	400
5 = 5V	2000	500
6 = 6V	2500	600
7 = 7V	3000	700
8 = 8V	3500	800
9 = 9V	4000	900
10 = 10V	- - -	1000

4.4 Tube Current (mA) Adjustment

The unit selects and regulates x-ray tube current as a function of kV. Check the x-ray tube current by measuring the voltage at TP4 (mA Sense) and TP17 (DGND) on the High Voltage Control board (Item 5, Figure 7-1). (The High Voltage Control board test points are identified in Chapter 7, Table 7-2.)

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Turn the unit OFF, then open the left and right side Gantry doors. On the Host Microprocessor, set the unit for the Calibration mode (S6 switch 4 = ON). Check that the Host is set appropriately for the installed x-ray tube (S4 to position 1; S6 switch 8 = ON).
2. Connect a voltmeter across R74 on the Filament Control board (primary filament current) (Item 7, Figure 7-1). (The Filament Control board test points are identified in Chapter 7, Table 7-4.) Connect Channel 1 of a storage oscilloscope to TP4 on the High Voltage Control board. Connect the probe ground to TP17 on the High Voltage Control board.
3. Locate the two position "banana" jack (Item 1, Figure 3-6) on the High Voltage Multiplier Board (for board location, refer to Chapter 7, Figure 7-1). Remove the jumper bar and plug in an mAs meter.

CAUTION!

NEVER operate the system without either the jumper or the mA meter installed into the mA/mAs meter "banana" jack.

4. Apply power to the unit, and perform the power up sequence. Record the voltage reading on the meter connected across R74. Multiply the voltage reading by 10 and verify that the product is 2.45 to 2.55 (indicating the standby current). Disconnect the meter across R74 on the Filament Board.
5. Check Filament over-current and over-voltage levels as per Chapter 7, Section 4.3.
6. Set the mAs Mode to MODE 2 (59 mAs levels). Set the unit for a Manual mode exposure at 25 kV, Large focal spot, 100 mAs, then make an exposure. Verify that the mAs reading on the meter is between 96 and 104 mAs (±.5 mAs). If not, adjust R20 on High Voltage Control board for 100 mAs, as required.
7. Set the oscilloscope to acquire and store a single sweep as follows:

   Trigger: Channel 1

   Vertical: DC Volts 0.2/division (small focus)

   DC Volts 0.5/division (large focus)

   Horizontal: 20 milliseconds, Single Sweep
8. Set the unit for Manual mode exposure at 20 kV, 3 mAs. Press x-ray switches and examine the acquired waveform.
9. Examine the waveform 10 ms (0.01 sec.) from the leading edge of the waveform for under- or over-shoot. A reference waveform is shown in Figure 3-5. If undershoot or overshoot exists, set the Host Microprocessor for Filament Calibration (S4 to position 2, S6 switch 8 OFF). Press S5 to increase (for undershoot) or press S3 to decrease (for overshoot) the displayed value. Objective is to ensure the waveform is flat from 10 ms and greater.

10. Make another exposure and check the waveform again for under- or overshoot. Repeat the adjustments and exposures until the waveform is stable.
11. Advance to the next kV station (21) then repeat the exposures and adjustments as per Step 9. Continue advancing through the kV stations for the large focal spot until all kV stations have been adjusted.
12. Repeat Steps 9 through 11 for small focal spot.
13. For units that do not have an HTC Bucky, go to Step 14. For units equipped with HTC Bucky, install HTC Bucky and repeat Steps 9 through 11 for large focal spot. In manual mode, reduce mAs below 40 mAs. Host will display “HTC FIL”.
14. When complete, turn the unit OFF, then set the Host Microprocessor for normal operation (S6 switch 4 = OFF). Remove all test equipment and Bucky, then close all covers and panels.

Reference Waveform Patterns

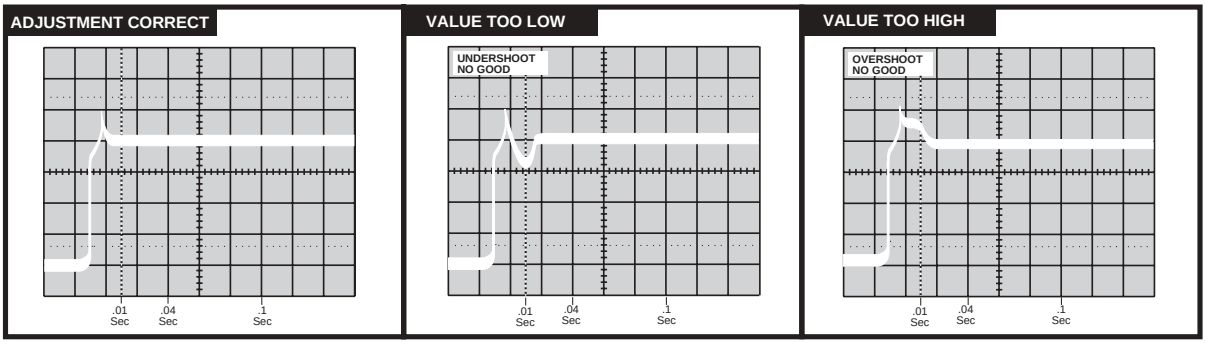


Figure 3-5: Waveforms Patterns

4.5 Tube Voltage Potential (kV) Adjustment

Checking the Tube Voltage requires using an invasive high voltage divider, a digital voltmeter, and an adapter cable to connect the divider to the test receptacle on the unit's High Voltage Generator.

WARNING!

This test generates extremely high, LETHAL voltages. Use all possible precautions to avoid accident or injury.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Make sure power is OFF. Open the left and right side Gantry doors. Allow sufficient time for the high voltage capacitor to discharge.

Note …A red LED (D14) on the Inverter board indicates the charge condition of the capacitor; while the LED is glowing, the capacitor is charged to over 100 volts. Allow the LED to stop glowing, then wait five additional minutes before continuing.

2. Connect a DC voltmeter to the low voltage terminals of a 10,000:1 or 1,000:1 Voltage Divider. Position the meter where it can be read from behind the radiation shield.
3. Connect the ground terminal of the Voltage Divider to chassis ground on the Gantry. Connect the free end of the High Voltage Adapter cable to the high voltage receptacle well on the High Voltage Multiplier (item 2, Figure 3-6). Push the adapter cable into the receptacle well until it is firmly seated.
4. Turn the system ON. Set the system for a 30 kV, 160 mAs, Manual mode exposure. While monitoring the meter from behind the protective radiation shield, take an exposure.
5. Confirm that the meter reading falls into these ranges:

2.94 - 3.06 volts (using a 10,000:1 divider)
29.4 - 30.6 volts (using a 1,000:1 divider)

6. If the voltage reading is more than 2% of the kV setting, adjust R18 on the High Voltage Control Board (clockwise to increase; counterclockwise to decrease).

Note…It may be necessary to adjust R18 so that the voltage reading for the 30 kV exposure is within 1% of the kV setting to ensure that the remaining kV levels fall within the 2% tolerance. Re-check the mA output if R18 is adjusted.

7. Repeat the exposure and adjustment as necessary to achieve the required voltage reading.
8. Select intermediate kV settings, and confirm that the meter readings are within 2% of their kV settings.

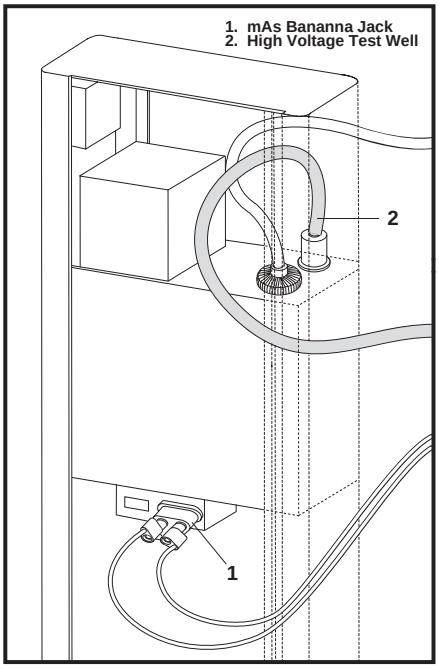


Figure 3-6: Test Well and Banana Jack - High Voltage Inverter

5.0 Automatic Exposure Control Calibration

These procedures detail the steps necessary to calibrate the M-IV Automatic Exposure Control (AEC) System. Calibration of the AEC is performed at the factory to assure that the system is capable of proper calibration and performance in the field. At installation, the AEC must be adjusted to obtain films of the proper mean optical density (typically 1.3 OD {optical density} to 1.6 OD depending on the radiologist's preference) using the site's processing equipment.

Note …This procedure MUST be performed for each film type used with the unit.

AEC system performance is specified at the kV stations which are normally used clinically. Table 3-14, "Typical kV range vs. compressed thickness," presents a guideline for typical clinical values for breast composition and thickness.

Table 3-14: Typical kV range vs. compressed thickness

THICKNESS	FATTY	50/50	DENSE
2 cm	23-24kV	24-25kV	25-26kV
4 cm	25-26kV	26-27kV	27-28kV
6 cm	26-27kV	27-28kV	29-30kV

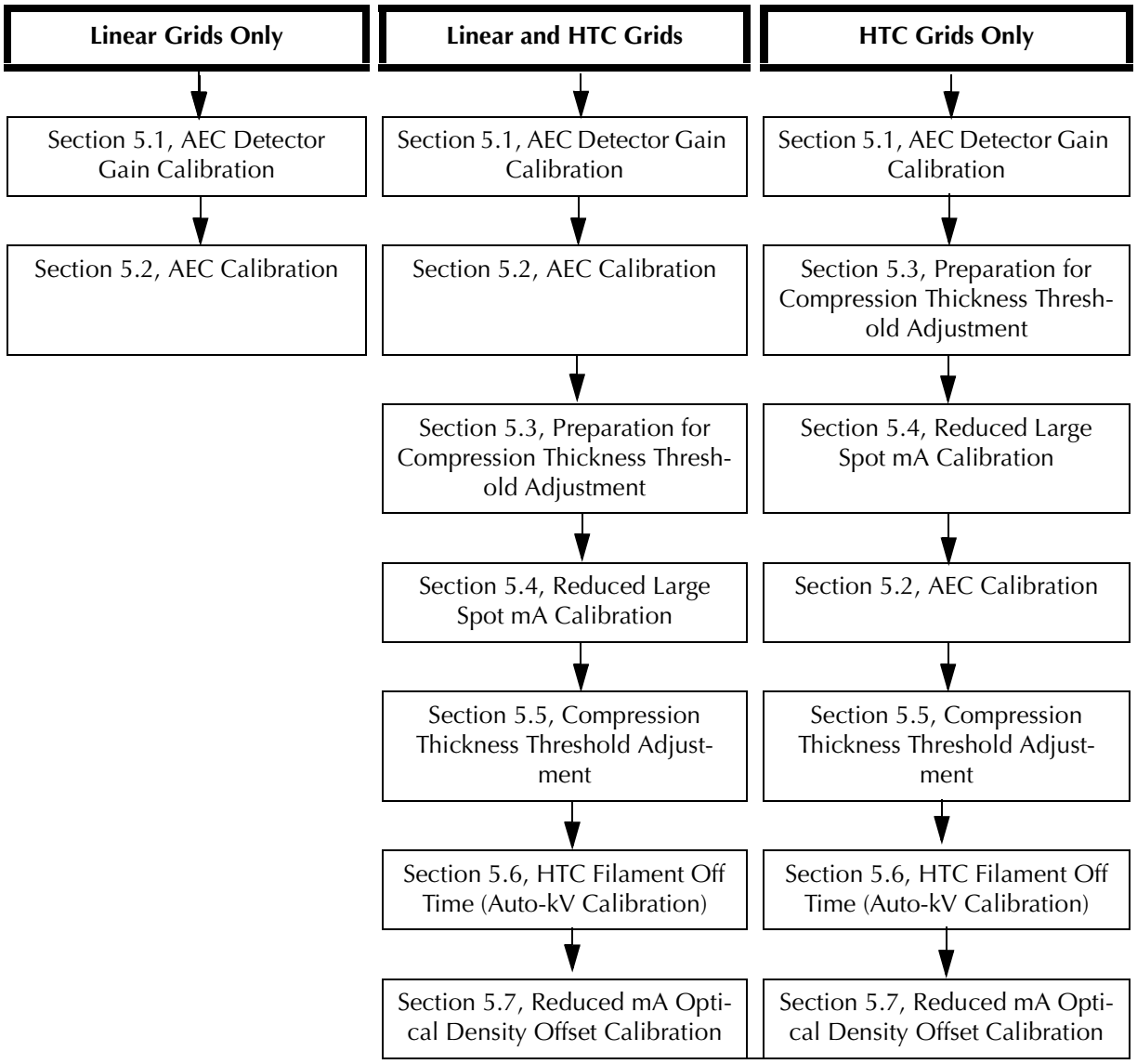
Note …2 cm thickness imaging is not appropriate above 26 kV, while 6 cm thickness imaging is not appropriate below 26 kV.

ALWAYS perform this calibration and setup procedure in the sequence presented to ensure accurate calibration.

Section 4.0, the Exposure System Calibration Procedures, must be performed prior to starting AEC Calibration.

Table 3-15, "AEC Calibration Procedures," provides a Flow Chart of the order in which the AEC Calibration procedures must be performed on systems with Linear Grids only, both Linear and HTC Grids, and with HTC Grids only.

Table 3-15: AEC Calibration Procedures


Linear Grids Only
Linear and HTC Grids
HTC Grids Only
Section 5.1, AEC Detector Gain Calibration
Section 5.2, AEC Calibration
Section 5.1, AEC Detector Gain Calibration
Section 5.2, AEC Calibration
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Section 5.5, Compression Thickness Threshold Adjustment
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Section 5.7, Reduced mA Optical Density Offset Calibration
Section 5.1, AEC Detector Gain Calibration
Section 5.3, Preparation for Compression Thickness Threshold Adjustment
Section 5.4, Reduced Large Spot mA Calibration
Section 5.2, AEC Calibration
Section 5.5, Compression Thickness Threshold Adjustment
Section 5.6, HTC Filament Off Time (Auto-kV Calibration)
Section 5.7, Reduced mA Optical Density Offset Calibration

5.1 AEC Detector Gain Calibration

1. Remove the IRSD cover as per Chapter 5, Section 2.5, Steps 1 through 6.
2. Install the IRSD on the C-arm (cover removed).
3. Install an M-IV Bucky (Linear or HTC) on the IRSD. Install a loaded cassette. Center 2 cm of B.E.M. on the surface of the Bucky so that it covers the AEC detectors and extends beyond the chest wall edge.
4. Set the unit for a Manual mode exposure at 30 kV, 50 mAs.
5. Connect an oscilloscope to TP7 (AOUT) on the Image Receptor Microprocessor Board. Connect the scope ground to TP22 (AGND).
6. Make an exposure and verify that the scope reading is between 9.0 VDC and 9.5 VDC If it is not, the AEC Detector Gain will need to be adjusted to obtain a voltage reading as close to, but not exceeding, 9.5 VDC If adjustment is required, proceed to the next step. If no adjustment is required, proceed to the next section.

Note …Refer to Section 1.0 of this Chapter for further information on switch settings.

7. Set the Host Microprocessor for AEC Detector Gain Calibration (S4 = E; S6 switch 4 = ON; S6 switch 8 = ON). Press S2 until the display reads: "DetGN=##". Press S5 to change the value.
8. If the initial voltage reading is more than 9.5 VDC, reduce the GAIN value by 1, then retake the measurement. Continue the adjustment and measurement until the voltage reading falls below 9.5 VDC DO NOT reduce the GAIN value any further than the value that first achieves a voltage below 9.5 VDC
9. If the initial voltage reading is already less than 9.5 VDC, first increase the GAIN value by increments of 1 until you obtain a voltage reading above 9.5 VDC, then incrementally reduce the GAIN value as stated in step 6.
10. Remove IRSD from C-arm and replace the cover by reversing the procedures in Chapter 5, Section 2.5.

5.2 AEC Calibration

5.2.1 Initial Calibration - Mean Optical Density and Thickness Tracking

For systems with Linear Grids only, perform this procedure as written. For systems with the HTC Grid only, Section 5.3, Preparation for Compression Thickness Threshold Adjustment and Section 5.4, Reduced Large Spot mA Calibration must be performed prior to AEC calibration. For systems incorporating both Linear and HTC Grid, perform this procedure using the Linear Bucky.

Note …To ensure proper AEC tracking, exposures used to adjust the OFFSET must be taken between 200 mAs and 350 mAs. Exposures used to adjust the GAIN must be taken between 20 mAs and 35 mAs. By remaining within the specific mAs range settings given for both GAIN and OFFSET, adjustments made to one will minimally affect the other.

Note …Always take sample exposures, then adjust the amount of attenuation to achieve the proper mAs before making GAIN or OFFSET adjustments.

Note…All kV stations used clinically must be calibrated as per this procedure.

Note…To accurately perform AEC Calibration, you will need an 18 x 24 cm cassette and a 24 x 30 cm cassette that are matched for OD within 0.05 OD.

1. Open the right side Gantry door to access the Host Microprocessor. Set the Host Microprocessor to the Calibration Mode (S6 switch 4 = ON), then set the system for AEC Calibration (S4 to position E, S6 switch 8 = OFF).
2. Install the 18 x 24 cm Bucky and insert a loaded cassette. For Linear/HTC combination systems, install the 18 x 24 cm Linear Bucky and insert a loaded cassette.

Note…The 200 mrad window is most effective when the screen-film speed is 170 or less. It is generally not necessary to use the 200 mrad window when the screen-film speed is greater than 170. Please consult your Medical Physicist regarding screen-film combinations and the 200 mrad window for specific recommendations.

3. Set the unit for an Auto-Time exposure at 24 kV, Large focal spot, MO filter. Select one of the three available screen-film types to calibrate. Enter the setup screen and enter the name (Kodak, Fuji, etc.).

Note …Use the same cassette for all calibration steps.

Note…All AEC Calibrations should be done in the Auto-Time Mode.

4. Place 2 cm of BR12 or 50/50 Breast Equivalent Material (B.E.M.), or P.M.M.A. acrylic (also known as phantom material) on the Bucky, centered transversely, extending approximately 1 cm over the chest wall edge.

Note …Phantom material thickness requirements may vary depending on kV station being calibrated.

5. Place the AEC detector in the position closest to the chest wall. Take an exposure, develop the film, then measure the optical density (OD).

Note …Always measure the Optical Density with the lower edge of the film flush with the front edge of the Densitometer and centered side-to-side (approximately 5.0 cm into film plane).

6. Using initial exposure as starting point, adjust the Optical Density to the value requested by the customer. Press S2 until the GAIN value appears on the display. Decrease (S3) the value if the density is too light, or increase (S5) the value if the density is too dark, then press S1 to save the new value.
7. Make another exposure, develop the film, then measure the Optical Density. Repeat the GAIN adjustments and exposures as necessary to obtain the ±0.12 OD from the mean OD requirement. Always save the values after making a change. Record the value on the Performance Test Worksheet, Table 3-16.
8. Replace the 2 cm phantom material with the 5 cm phantom material. Using the same techniques, make an exposure, develop the film, then measure the Optical Density.
9. Press S2 until the OFFSET value appears on the display. Modify the value to increase or decrease the Optical Density (S3 and S5). Increasing the OFFSET decreases the Optical Density; decreasing the OFFSET increases the Optical Density.
10. Make an exposure, develop the film, then measure the Optical Density. Repeat the OFFSET adjustments and exposures as necessary to obtain the ±0.12 OD from the mean OD requirement. Record the value on the Performance Test Worksheet, Table 3-16.
11. Replace the 5 cm phantom material with the 4 cm phantom material, make an exposure, develop the film, then measure the Optical Density. Make sure that the Optical Density reading is within ±0.12 OD of that at 5 cm. Record the value on the Performance Test Worksheet, Table 3-16.
12. Repeat the entire procedure for each kV station (25 kV to 32 kV) being calibrated.

Table 3-16: Performance Test Worksheet—Large Focal Spot (Mo)

	Gain Cal				Cal Check			Offset Cal			
kV	cm	mAs	O.D.	Gain	cm	mAs	O.D.	cm	mAs	O.D.	Offset
24					4				*	*	
25					4				*	*	
26					4						
27		*			4						
28		*			5						
29		*			5						
30		*			5						
31		*			5						
32		*			5						

*** These values may exceed the timing capabilities of the system due to different screen-film speeds.

5.2.2 Input AEC Values - 20 kV - 23 kV and 33 kV - 39 kV (Large Focus)

1. Input the values for MASTER DENSITY, GAIN, and OFFSET used at 24 kV for each corresponding value for 20 kV - 23 kV.
2. Input the values for MASTER DENSITY, GAIN, and OFFSET used at 32 kV for each corresponding value 33 kV and above.

5.2.3 AEC Calibration - Large Focal Spot (Rh Filter)

Note…The following procedure will require phantom material thicknesses greater than 6 cm.

1. Repeat Section 5.2.1 using Rhodium (Rh) filter at 28 kV - 32 kV. Record the values on the Performance Test Worksheet, Table 3-17.
2. Use appropriate phantom material thicknesses (3 cm to 7 cm typical, starting at 28 kV) to make GAIN adjustments in the 20 to 35 mAs range.
3. Use appropriate phantom material thicknesses to make OFFSET adjustments in the 200 mAs to 350 mAs range.

Table 3-17: Performance Test Worksheet—Large Focal Spot (Rh)

	Gain Cal				Cal Check			Offset Cal			
kV	cm	mAs	O.D.	Gain	cm	mAs	O.D.	cm	mAs	O.D.	Offset
28	*				3				*	*	
29	*				3				*	*	
30	*				4						
31	*				4						
32	*				4						

*** These values may need to be increased to meet the timing capabilities of the system.

5.2.4 Small Focal Spot - Mean Optical Density and Thickness Tracking

Note …Use the same cassette for all calibration steps.

1. Set the unit for an exposure Auto-Time exposure at 25 kV, Small focal spot, Mo filter.
2. Remove the Bucky device and install the Magnification Table. Place 2 cm of BR-12, 50/50 B.E.M. or P.M.M.A. acrylic on the Magnification Table, centered laterally, and extending over the chest wall edge approximately 1 cm, using the 10 cm or 15 cm mag paddle.

Note …Phantom material thickness requirements may vary depending on kV station being calibrated.

3. Place the AEC detector in the position closest to the chest wall. Take an exposure, develop the film, then measure the optical density (OD).

Note …Always measure the Optical Density with the lower edge of the film flush with the front edge of the Densitometer and centered side-to-side (approximately 5.0 cm into film plane).

4. Using initial shot as starting point, adjust the Optical Density to the value requested by the customer. Press S2 until the GAIN value appears on the display. Decrease (S3) the value if the density is too light, or increase (S5) the value if the density is too dark, then press S1 to save the new value.
5. Make another exposure, develop the film, then measure the Optical Density. Repeat the GAIN adjustments and exposures as necessary to obtain the ±0.12 OD from the mean OD requirement. Always save the values after making a change. Record the value on the Performance Test Worksheet, Table 3-18.
6. Replace the 2 cm phantom material with the 4 cm phantom material. Using the same techniques, make an exposure, develop the film, then measure the Optical Density.
7. Press S2 until the OFFSET value appears on the display. Modify the value to increase or decrease the Optical Density (S3 and S5). Increasing the OFFSET decreases the Optical Density; decreasing the OFFSET increases the Optical Density.
8. Make an exposure, develop the film, then measure the Optical Density. Repeat the OFFSET adjustments and exposures as necessary to obtain the ±0.12 OD from the mean OD requirement. Record the value on the Performance Test Worksheet, Table 3-18.
9. Replace the 4 cm phantom material with the 3 cm phantom material, make an exposure, develop the film, then measure the Optical Density. Make sure that the Optical Density reading is within ±0.12 OD of that at 4 cm. Record the value on the Performance Test Worksheet, Table 3-18.
10. Repeat the entire procedure for each kV station (25 kV to 30 kV) being calibrated.

Table 3-18: Performance Test Worksheet—Small Focal Spot (Mo)

	2cm		3cm		4cm	
kV	mAs	O.D.	mAs	O.D.	mAs	O.D.
25					***	***
26						
27						
28	***					
29	***					
30	***					
31	***					

***For these kV values, 3 cm or greater may be required.

5.2.5 Input AEC Values - 20 kV - 24 kV and 33 kV - 35 kV (Small Focus)

1. Input the values for MASTER DENSITY, GAIN, and OFFSET used at 25 kV for each corresponding value for 20 kV - 24 kV.
2. Input the values for MASTER DENSITY, GAIN, and OFFSET used at 32 kV for each corresponding value for 33 kV and above.
3. When complete, return all switches to their defaults and return unit to normal operations (Run Mode).

5.2.6 AEC Calibration - Small Spot (RH Filter)

Note …While there are currently no requirements for (Rh) using Small Focal Spot, some physicists may require calibration be done on any user selectable kV-Filter combination, therefore, (Rh) Small Focal Spot calibration may be required.

1. Repeat Section 5.2.4 using Rhodium (Rh) filter at 28 kV - 32 kV. (Ensure S4 is set to E; S6 switch 4 = ON; and S6 switch 8 = ON.)
2. Enter the values from the Small Focal Spot Performance chart as the starting values for Rhodium filter calibration.
3. Record the values on the Performance Test Worksheet, Table 3-19.
4. When complete, return all switches to their defaults and return unit to normal operations (Run Mode).

Table 3-19: Performance Test Worksheet—Small Focal Spot (Rh)

	2cm		3cm		4cm	
kV	mAs	O.D.	mAs	O.D.	mAs	O.D.
28	***					
29	***					
30	***					
31	***					
32	***					

***For these kV values, 3 cm or greater may be required.

5.3 Preparation for Compression Thickness Threshold Adjustment

1. Verify the Optical Density Offset Factor is set at "HaecF85", if not, adjust to 85.
2. Turn S4 to position 2 on the Host Board and set S6 switch 8 to ON. Using S3 or S5, change the displayed value to 4 cm.

5.3.1 Reduced mA OD Offset Factor Initial Adjustment

1. Adjust the rotary switch on the Host Board to position E.
2. Press S2 until the Host display reads "HaecF###.
3. Using switch S3 on the Host, adjust the display to read "HaecF85".
4. Turn S6 switch 8 OFF.

5.4 Reduced Large Spot mA Calibration

1. Return to Section 5.3 step 8 and program your calculated threshold.
2. Install the HTC Bucky Device on the IRSD.
3. Set the unit for a Manual mode exposure at 25 kV, 12 mAs. Return Host to Fil Cal (Host Display should read HTC=xxxx).
4. Connect Channel 1 of a storage oscilloscope to TP4 (mA sense) on the High Voltage Control Board. Connect the probe ground to TP17 (GND) on the High Voltage Control Board.
5. Using the same sequence as the Tube Current Adjustment (mA), check each kV station for under- or overshoot.
6. If adjustment is necessary, set the Host Microprocessor for Filament Calibration (S4 at position 2). Press S5 to increase (for undershoot) or press S3 to decrease (for overshoot) the displayed value.
7. Continue making exposures and adjustments as needed until the waveform at each kV station is stable and at the correct amplitude.

5.5 Compression Thickness Threshold Adjustment

1. Place 3 cm of B.E.M. or P.M.M.A. acrylic on the Bucky, centered laterally and extending 1 cm over the chest wall edge. Use motorized compression to lower the compression paddle onto the phantom material.
2. Insert a loaded cassette into the Bucky, then make a 25 kV Auto-Time exposure. Record the mAs value (as point "A") on the semi log worksheet (Chapter 4, Table 4-1, "Beam Quality Semi-Log (Half value Layer),").
3. Release compression and place 5 cm of phantom material on the Bucky. Reapply compression, then make a second exposure. Record this mAs value (as point "B") on the semi log worksheet.
4. Draw a line between points "A" and "B" on the semi log. Follow the left side of the graph and locate the 80 mAs point. Draw a straight line and intercept the line between the 2 points.
5. Draw a vertical line from that point to the bottom of the graph and note the compression thickness value indicated. This is the compression thickness threshold value.
6. Turn S4 to position 2 on the Host board. Place S8 to ON. Using S3 (decrease) or S5 (increase), change the displayed value to the value calculated on the graph.

5.6 HTC Filament Off Time (Auto-kV Calibration)

The Auto-kV Mode makes either one or two sample exposures, depending on if the kV changes or remains the same. The system enters a standby condition (filament at load, no x-rays) after the first sample, which permits the HTC grid to return to the 'home" position. During the standby condition, the filament must turn "off" (load removed) momentarily to prevent over- or undershoot during the second sample. This procedure adjusts the filament "off" time to provide a stable second sample.

5.6.1 Adjustment—Off Time (100 mA)

1. Install the HTC Bucky Device on the IRSD, then raise the Compression Device completely.
2. Set the unit for an Auto-kV exposure, with a 25 kV start. Completely block the AEC detector with lead.
3. Connect a storage oscilloscope to TP4 (mA sense) on the High Voltage Control Board, then connect the probe ground to TP24 (AGND).
4. Make an exposure and check the second sample waveform for under- or overshoot. If adjustment is required, set the Host Microprocessor for the 100 mA "off time" adjustment (S4 at position 4, S6 switch 8 = ON). Press S2 until the display reads "HfilHi".
5. Decrease the value if the waveform indicates undershoot; increase the value if the waveform indicates overshoot.
6. Continue making adjustments and exposures until the second sample waveform is stable.

5.6.2 Adjustment—Off Time (reduced mA)

1. With the HTC Bucky Device on the IRSD, lower the compression device completely.
2. Set the unit for an Auto-kV exposure, with a 25 kV start. Completely block the AEC detector with lead.
3. Connect a storage oscilloscope to TP4 (mA Sense) on the High Voltage Control Board, then connect the probe ground to TP24 (AGND).
4. Make an exposure and check the second sample waveform for under- or overshoot. If adjustment is required, set the Host Microprocessor for the reduced mA "off time" adjustment (S4 at position 4, S6 switch 8 = ON). Press S2 until the display reads "HfilLo".
5. Decrease the value if the waveform indicates undershoot; increase the value if the waveform indicates overshoot.
6. Continue making exposures and adjustments until the second sample waveform is stable.

5.7 Reduced mA Optical Density Offset Calibration

Note…This procedure is only necessary if you have HTC grid Buckys.

1. Install the HTC Bucky device on the M-IV image receptor support. Place a loaded cassette into the Bucky device.
2. Set the unit for an Auto-Time exposure at 25 kV Place 3 cm of B.E.M. on the Bucky and center it over the exposure detectors. Raise the compression device above the compression height threshold setting.
3. Make an exposure, remove the cassette, then develop the film. Measure the optical density of the film and record.
4. Place the same cassette in the HTC Bucky with 3 cm of B.E.M. and lower the compression device on to the phantom (paddle must be below the threshold). Release an exposure and develop the film.
5. The Reduced mA exposure must be within 0.12 OD of the 100 mA exposure. If it is not, set the Host Microprocessor for HTC REDUCED mA CAL (S4 at position E, S6 switch 8 = ON). Press S2 until the Host display reads: "HaecF###".
6. If the OD is too light, increase (S3) the value, then repeat the exposure and optical density measurement.
7. If the OD is too dark, decrease (S5) the value, then repeat the exposure and optical density measurement.
8. Continue this process until the reduced mA OD measurement matches the 100 mA OD measurement within 0.12 OD

6.0 Download—Calibration Values

The following method permits the user to download the calibration data to text file or a floppy disk (via Windows™ terminal mode), which can then be saved to a computer.

1. Use a serial cable to link the laptop computer to the Host Microprocessor Board (KJ15). Enter Windows™ terminal mode on the computer. Insert a floppy diskette into the computer's floppy disk drive.
2. On the Host Microprocessor, set the system for the calibration mode (S6 switch 4 = ON). Set the system for calibration range 2 (S6 switch 8 = OFF). Select position 0 on the Host Rotary Switch (S4).
3. On the Host Microprocessor, press S1 seven times (once for each page of the calibration printout). When the transfer is complete, select "Stop" from the menu.

The file / printout will contain the calibration values for:

- Filament Preheat
- Angle
- Compression Force and Compression Height
- Magnification Compression Height
- Mirror, Filter, and Aperture Blade Positions
- Film 1, 2, and 3 AEC Values (Mo and Rh)

7.0 Final Set Up Checks

Perform these checks as necessary to calibrate the AutoFilm ID, or to reset the x-ray tube exposure counter.

7.1 AutoFilm ID Setup

This procedure checks that the AutoFilm ID is working properly, and that the information on the film label is legible.

1. Set the unit for a MANUAL mode exposure at 25 kV, 20 mAs. For this exposure, use Film #1 and the Molybdenum (Mo) filter.
2. In the ID Data Field, type "1" for each character in the field. In the Patient Name Data Field, type "A" for each character in the field.
3. Type in the Birth Date 01-01-50, then set the Sex data field to "F". Enter the 123 as the Tech ID. Enter 12345 as the CPT Code, then select L MLO as the exam view.
4. In the "Comments" data field, type the following: Routine Screening.
5. Place a loaded Bucky device on the IRSD. Install a Compression Paddle, then place 4cm of B.E.M. on the Bucky. Apply compression until the force readout indicates 20 lbs, and the thickness readout indicates 4cm.
6. Rotate the C-arm to -50°, then move the AEC detector to position #4.
7. Make the exposure, remove the cassette, insert the cassette into the AutoFilm ID, then remove the cassette and develop the film.
8. Check the contrast of the "flashed" label. If adjustment is necessary, access the Additional Setup screen and change the value in the Auto ID Contrast data field., then repeat the test.
9. Check the character definition of the "flashed" label. If adjustment is necessary, adjust the Flash Duration (increase value to increase character brightness, decrease value to decrease character brightness).
10. Check the placement of the flashed label relative to the edge of the film. If adjustment is required, access the Additional Setup screen and change the value in the Auto ID Offset data field, then repeat the test.
11. Check that all the information on the "flashed" label is correct. An example is shown in Figure 3-7.

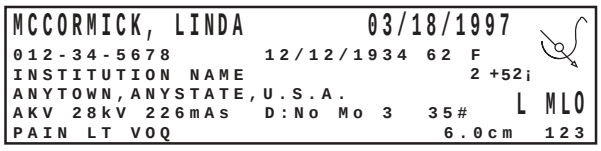

MCCORMICK, LINDA 03/18/1997
012-34-5678 12/12/1934 62 F
INSTITUTION NAME 2 +52i
ANYTOWN,ANYSTATE,U.S.A.
AKV 28kV 226mAs D:No Mo 3 35# L MLO
PAIN LT VOQ 6.0cm 123

Figure 3-7: Example - AutoFilm ID Label

7.2 Exposure Counter Reset

This procedure details resetting the exposure counter. Perform these steps only after replacing the x-ray tube.

1. On the Host Microprocessor board, set the system to display the exposure counter (S4 - 0; S6 switch 8 ON).
2. Reset the exposure counter by pressing the Host switches S2 and S5 (below the LED Display) together.
3. When complete, return all switches to their normal operating positions.

7.3 C-arm Rotation Speed Check

The C-arm Rotation and Vertical Speed Control are both factory-set at 90% of their maximum possible levels. If the need arises to change them, the procedure to do so is as follows:

1. Set the Host Microprocessor to the calibration mode (S6 switch 4 = ON).
2. Set the Rotary Switch for the Rotation and Vertical Speed Controls mode (S4 to position 5; S6 switch 8 = ON).
3. On the Host Microprocessor, press Select (S2) until the desired category displays, i.e., Rotation or Vertical Speed, then press S3 to decrease the speed or S5 to increase the speed.
4. Set the Host Microprocessor for normal operation (S6 switch 4 = OFF).
5. Turn the M-IV OFF, wait a few seconds, then switch the unit back ON to have the desired change take effect.

7.4 Setting—Compression Release Distance

The Compression Release Distance is factory-set at 10 cm. If the need arises to change it, the service engineer has additional options for either 5 cm, 7.5 cm, or 12.5 cm. settings. The procedure to change the recommended setting is as follows:

1. Set the Host Microprocessor to the calibration mode (S6 switch 4 = ON).
2. Set the Rotary Switch for the Compression Release Distance mode (S4 to position 7; S6 switch 8 = ON).
3. On the Host Microprocessor, press Select (S2) until the desired setting appears (5 cm, 7.5 cm, 10 cm, or 12.5 cm).
4. Set the Host Microprocessor for normal operation (S6 switch 4 = OFF).
5. Turn the M-IV OFF, wait a few seconds, then switch the unit back ON to have the desired change take effect.

7.5 Setting—Auto-Filter kV Threshold and Offset

The Auto-Filter kV Threshold and the Auto-Filter kV Offset selection for the Rhodium filter are factory-set at 30 kV and zero kV respectively. The Auto-Filter kV Threshold setting is the kV value that results in producing images with essentially the same image contrast regardless of the beam filter used (Mo or Rh).

At this kV, the patient dose may be reduced by use of the Rh filter without a reduction of image quality. This Auto-Filter kV Threshold value is dependent on several factors including compressed thickness, breast composition, screen-film speed, and the x-ray spectra. The nominal setting is 30 kV. However, it may be set at 29 through 32 kV at installation.

In addition to the kV Threshold selection, the change-over kV may be altered downward by 1 kV (1 kV Offset selection). This selection results in Rh filter imaging at 1 kV less than if the image was taken with the Mo filter. This results in improved image contrast. However, the patient dose reduction is not as much as it would be with no kV Offset.

If the need arises to change these values, the procedure to do so is as follows:

1. Set the Host Microprocessor to the calibration mode (S6 switch 4 = ON).
2. Set the Rotary Switch for the Auto-Filter kV Threshold and Offset selection (S4 to position 6 and S6 switch 8 = ON).
3. On the Host Microprocessor, press Select (S2) until the desired setting appears, i.e., Auto-Filter kV Threshold or Auto-Filter Offset, then press S3 to decrease the value or S5 to increase the value.
4. Set the Host Microprocessor for normal operation (S6 switch 4 = OFF).

Chapter 4: Performance/Compliance Checks and Adjustment Procedures

1.0 Introduction

This section of the manual details the compliance checks, and their adjustment procedures. These checks include the X-ray System performance checks, the X-ray and Light Field Compliance checks, System Performance checks, and X-ray Shield checks. This section also provides the M-IV error codes and messages that appear on the Run Mode Screen.

After servicing the X-ray System, the following checks must be completed:

- Half Value Layer Check
- Reproducibility and Linearity (Manual Mode) Check
- Reproducibility (Auto-Time Mode) Check
- Reproducibility (Auto-kV Mode) Check
- Reproducibility (Auto-Filter Mode) Check

After servicing the components in the Tubehead, the following X-ray and Light Field checks and adjustments must be completed to ensure compliance:

- X-ray Beam Alignment Check and Adjustment
- Light Field Illuminance Check and Adjustment
- Light Field Alignment Check and Adjustment
- Light Field Edge Contrast Check

The following are standard System Performance Checks:

- Bucky Device (Linear) Performance Check
- Bucky Device (HTC Grid) Performance Check
- Maximum mAs in Auto-Time Mode
- System Level Functional Check

The following checks verify that the M-IV shielding meets requirements. Perform these checks as required after servicing the Tubehead or the IRSD.

- IRSD Leakage Check
- X-ray Tubehead Leakage Check

2.0 X-ray System Performance

The following checks verify the quality of the x-ray beam, the reproducibility of the x-ray generation system, and the consistency of the automatic exposure control system.

2.1 Half Value Layer Check

This compliance check verifies the quality of the x-ray beam. This ensures that the half-value layer (HVL) meets the requirements set forth by the FDA, 21 CFR, and the recommendations by the ACR/CDC. This check requires the use of the following equipment:

- Dosimeter
- Type 1145 aluminum filter pack (≥99.99% pure)

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Mount the 18 cm x 24 cm Compression Paddle, upside-down, onto the Compression Device. Raise the Compression Device until the paddle is approximately 1 cm below the tubehead port. See Figure 4-1.
2. Place a radiation probe approximately 5 cm above the IRSD. Position it so that it is centered laterally and 4 cm from the chest wall edge of the support device. Be sure that the probe is completely within the x-ray field.
3. Turn the system ON. Press the LIGHT FIELD button to illuminate the x-ray field. Reposition the probe so that the radiation detector is centered in the beam and 4 cm from the chest wall edge. Align the surface of the probe perpendicular to the beam axis. Adjust the collimator to the smallest field size that can fit the radiation probe.
4. Select Manual mode and the Large focal spot. Set the unit for an exposure at 30 kV, 100 mAs, molybdenum (Mo) filter. Make an exposure (without an aluminum sheet in the x-ray field) and record the milliroentgen reading on the semi log (Table 4-1).

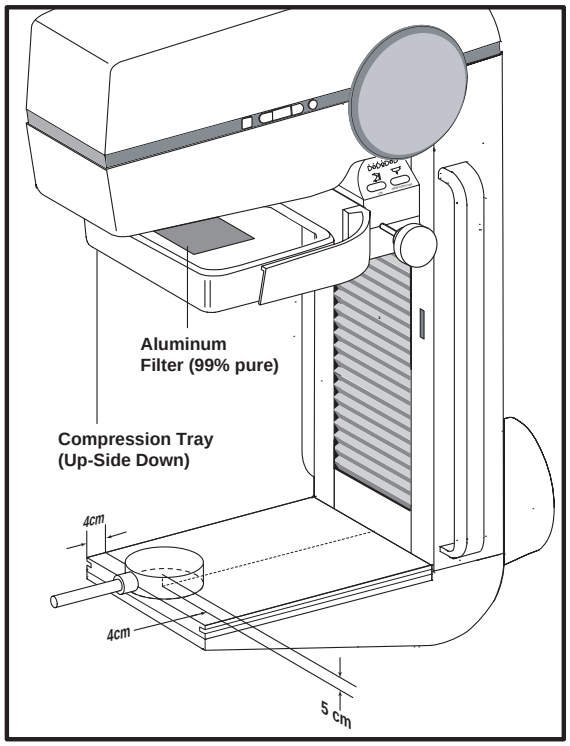
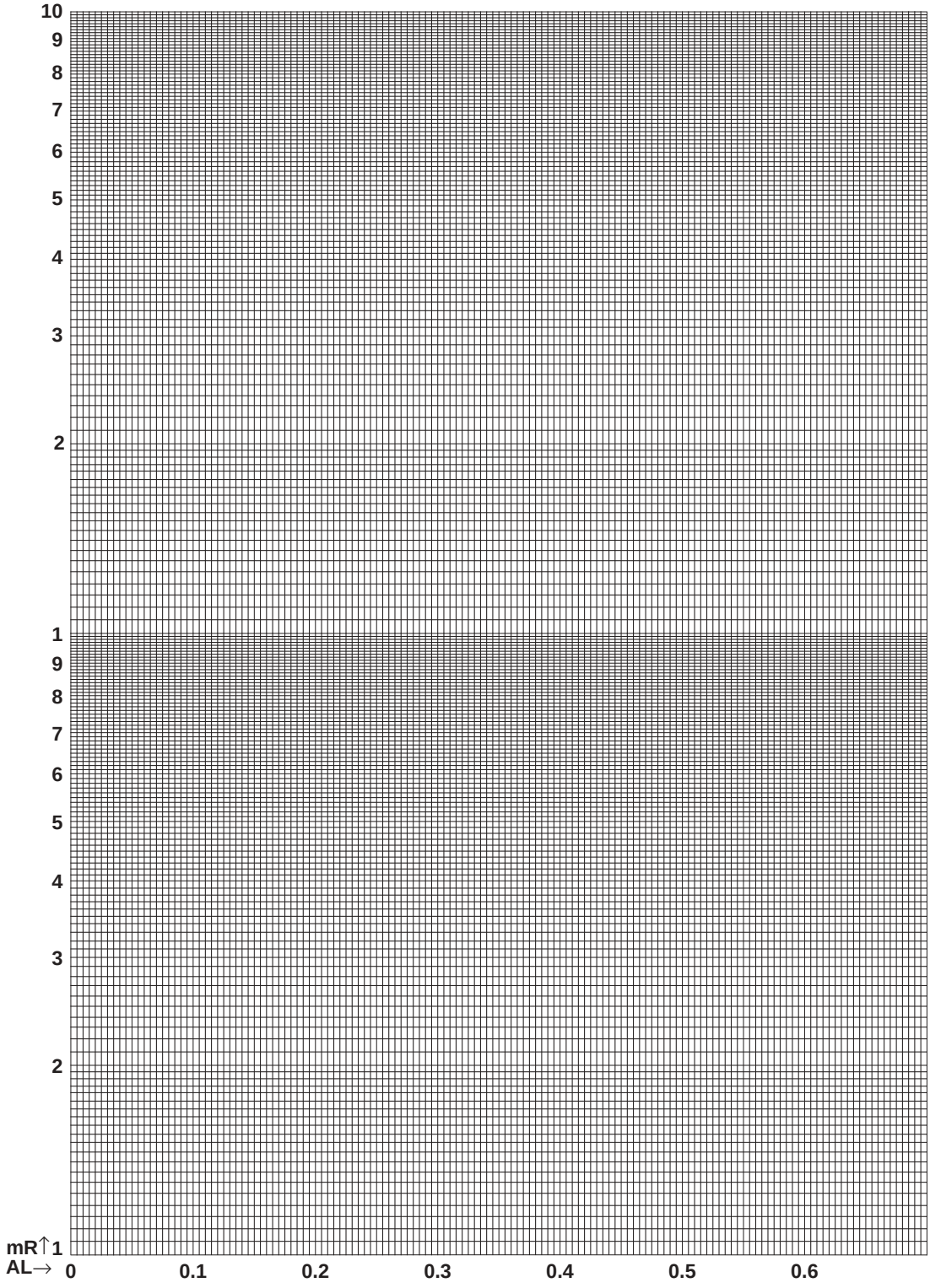


Figure 4-1: Half Value Layer Setup

5. Add 0.2 mm of aluminum between the x-ray tube and the radiation probe by placing the aluminum sheet in the Compression Paddle. Use the light field lamp to verify that the aluminum sheet completely blocks the x-ray beam path to the radiation probe. Make another exposure and record the milliroentgen reading on the semilog.
6. Repeat step #5 with additional 0.1 mm sheets of aluminum between the x-ray tube port and the radiation probe. Record the milliroentgen reading on the semi log after each exposure until the reading is less than one-half the original step #4 exposure reading (without aluminum).
7. Draw a line on the semilog through the plotted mR readings. It may be necessary, in cases where the plotted readings are not linear, to draw the line to achieve a "best fit" path.

8. Determine the exact half value of the step #4 mR reading and record this on the semi-log. Draw a horizontal line, starting from this plot, across the semilog until it intersects with the line plotted in step #7.
9. Draw a vertical line through the intersection to the bottom of the semi log. This is the half-value layer. Verify that the half-value layer is equal to, or greater than 0.33 mm AL, and less than 0.42 mm Al.
10. Select the Rhodium (Rh) filter, then repeat steps #4 through #9 to obtain the half value layer for the Rhodium filter. Verify that the half-value layer is equal to, or greater than 0.33 mm Al, and less than 0.49 mm Al.

Table 4-1: Beam Quality Semi-Log (Half value Layer)



2.2 Reproducibility and Linearity (Manual Mode) Check

The following test verifies that the x-ray system, including the controls and x-ray tube, is operating within the reproducibility and linear requirements of 21 CFR. Failure to meet these performance standards indicates the need to check the calibration of the H.V. Generator or the x-ray tube.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Connect a 10 cm radiation probe to a dosimeter, then set the meter to read milliroentgens. Position the meter so that it can be read from behind the radiation shield. See Figure 4-2.
2. Turn the unit ON, select Manual collimation, and then illuminate the light field. Limit the field to the approximate size of the probe, then center the probe's detector in the x-ray field. Align the surface of the probe so that it is perpendicular to the beam axis.
3. Set the unit for a Manual mode exposure at 25 kV, 60 mAs, Large focal spot. Select the molybdenum filter (Mo), and make an exposure. Record the milliroentgen reading on the Reproducibility Worksheet (Table 4-2).
4. Change the exposure techniques for both kV and mAs, then return them to 25 kV and 60 mAs. Again, make an exposure and record the milliroentgen reading on the Reproducibility Worksheet.
5. Continue to randomly change the technique data for kV and mAs, and return them to 25 kV and 60 mAs. Make exposures in this manner until 10 individual exposure are made. Record each milliroentgen reading on the Reproducibility Worksheet.
6. Compute and record the average milliroentgen reading on the Reproducibility Worksheet. Subtract each actual reading from the average, and square each difference. Add the squares and divide the sum by 9. Then take the square root of the result.
7. Divide the number calculated in Step 6 by the average milliroentgen reading to obtain the coefficient of variation. The coefficient of variation must be less than 0.05.
8. Leave the configuration on the IRSD the same. Change the exposure data to 25 kV and 20 mAs. Make an exposure and record the milliroentgen reading on the Linearity Worksheet (Table 4-3).

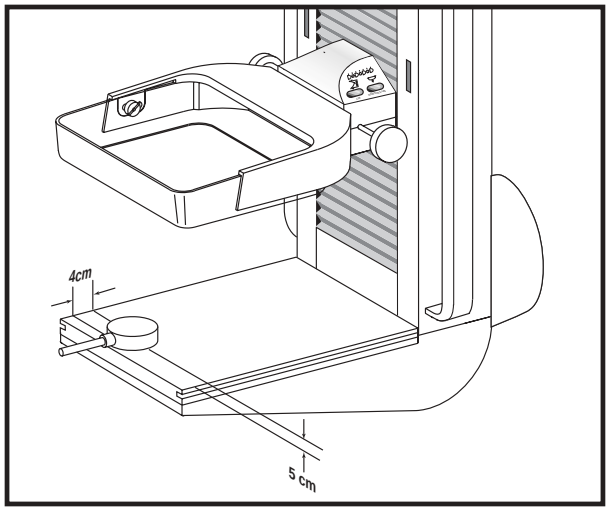


Figure 4-2: Setup—Reproducibility and Linearity Check

9. Repeat Step 8, changing the mAs to 60, 100, 150, 200, 250, 300, 400, and 500 for each exposure. Record milliroentgen readings at each setting on the Linearity Worksheet.

TABLE 4-2: REPRODUCIBILITY TEST WORKSHEET

A: TEST EXPOSURES 1-10

EXPOSURES	1	2	3	4	5	6	7	8	9	10
TECHNIQUE SETTING	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs	25kV 60mAs
RECORDED READING (mR)										

B: MEAN

AVERAGE OF 'STEP A' READINGS (mR)

C: SUBTRACT

SUBTRACT EACH 'STEP A' VALUE FROM THE AVERAGE										

D: SQUARE

'STEP C' VALUES SQUARED										

E: ADD

ADD 'STEP D' VALUES.

F: DIVIDE

DIVIDE 'STEP E' VALUE BY 9.

G: SQ ROOT

TAKE SQUARE ROOT OF 'STEP F' VALUE.

H: DIVIDE

DIVIDE 'STEP G' VALUE BY 'STEP B' VALUE

COEFFICIENT OF VARIATION

NOTE:
THE COEFFICIENT OF VARIATION MUST BE LESS THAN 0.05 mR.

NOTE:
To use a statistical calculator in place of this worksheet, perform the following to determine the coefficient of variation:

- **Determine the MEAN VALUE**
- **Determine the STANDARD DEVIATION**
- **Calculate the COEFFICIENT OF VARIATION using the formula:**

$$C = \frac{s}{x}$$

C = coefficient of variation
s = standard deviation
x = mean value

This worksheet may be copied by the service technician in order to accurately document test values.

Table 4-3: Linearity Worksheet

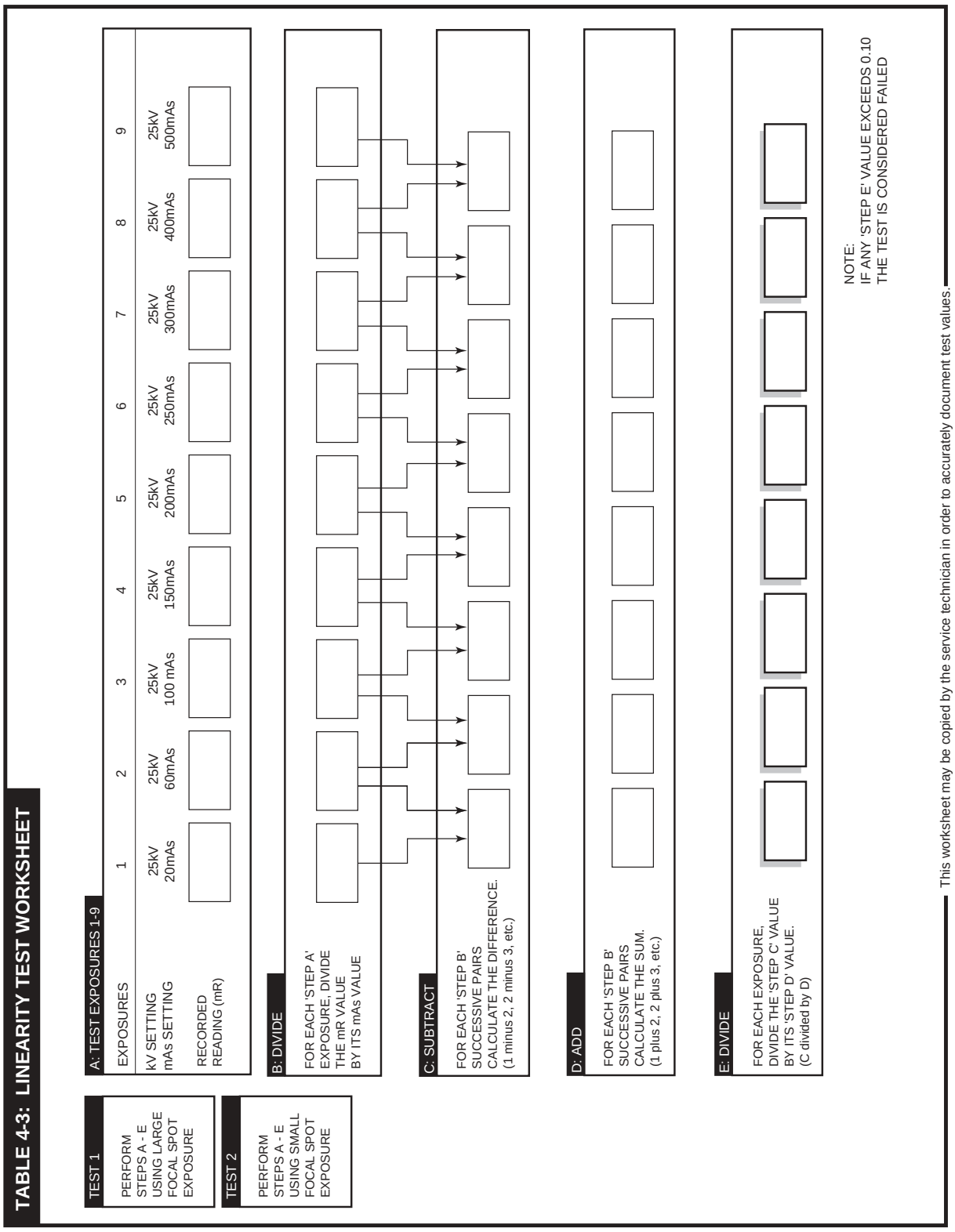


TABLE 4-3: LINEARITY TEST WORKSHEET
TEST 1
PERFORM STEPS A - E USING LARGE FOCAL SPOT EXPOSURE
TEST 2
PERFORM STEPS A - E USING SMALL FOCAL SPOT EXPOSURE
A: TEST EXPOSURES 1-9
EXPOSURES
1
2
3
4
5
6
7
8
9
kV SETTING
mAs SETTING
25kV 20mAs
25kV 60mAs
25kV 100 mAs
25kV 150mAs
25kV 200mAs
25kV 250mAs
25kV 300mAs
25kV 400mAs
25kV 500mAs
RECORDED READING (mR)
B: DIVIDE
FOR EACH 'STEP A' EXPOSURE, DIVIDE THE mR VALUE BY ITS mAs VALUE
C: SUBTRACT
FOR EACH 'STEP B' SUCCESSIVE PAIRS CALCULATE THE DIFFERENCE. (1 minus 2, 2 minus 3, etc.)
D: ADD
FOR EACH 'STEP B' SUCCESSIVE PAIRS CALCULATE THE SUM. (1 plus 2, 2 plus 3, etc.)
E: DIVIDE
FOR EACH EXPOSURE, DIVIDE THE 'STEP C' VALUE BY ITS 'STEP D' VALUE. (C divided by D)
NOTE:
IF ANY 'STEP E' VALUE EXCEEDS 0.10
THE TEST IS CONSIDERED FAILED
This worksheet may be copied by the service technician in order to accurately document test values.

10. Divide each milliroentgen reading by its corresponding mAs value and record on the Linearity worksheet.
11. For each pair of successive tests (20 mAs and 60 mAs, then 60 mAs and 100 mAs, and so on), calculate the difference between each corresponding Step 10 result and record on the Linearity worksheet.
12. For each pair of successive tests (20 mAs and 60 mAs, then 60 mAs and 100 mAs, and so on), calculate the sum of each Step 10 result and record on the Linearity Worksheet.
13. Divide each Step 11 difference value by each Step 12 sum value. If the result for any pair exceeds 0.10, the test is considered failed.
14. Repeat steps 8 through 13 using the Small focal spot. If the unit fails any part of the above test, first recheck all calculations, then repeat the tests.

2.3 Reproducibility (Auto-Time Mode) Check

The following test verifies that the Automatic Exposure Control system is reproducible in the Auto-Time exposure mode. Failure to meet this performance test indicates the need to check the calibration of the Automatic Exposure Control System.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Mount a cassette holder (with an empty cassette) onto the IRSD. Place a 4 cm acrylic phantom on the cassette. Position a radiation probe (10 square cm) on top of the phantom. Align the probe position with the AEC sensor at front center on the IRSD. Use the light field and collimate the x-ray field to the approximate size of the probe.
2. Set the unit for an exposure with the following factors: 25 kV, Large focal spot, Molybdenum filter. Select Auto-Time exposure mode, then make 10 exposures. Record milliroentgen reading for each exposure.
3. Calculate the average milliroentgen reading. Subtract each actual reading from the average. Square each difference. Add the squares and divide their sum by 9. Take the square root of the result.
4. Divide the number obtained in Step 3 by the average milliroentgen reading. The quotient, called the coefficient of variation, must be less than 0.05.

Note …To calculate the coefficient of variation, use the Reproducibility Worksheet (Table 4-2) which sequences the steps to manually calculate the quotient. The worksheet also provides the formula for calculating the quotient using a statistical calculator. Note that the mAs value is not set for this check.

2.4 Reproducibility (Auto-kV Mode) Check

The following test verifies that the automatic exposure control system is reproducible in the Auto-kV exposure mode. Failure to meet this performance test indicates the need to check the calibration of the Automatic Exposure Control System.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Mount a cassette holder (with an empty cassette) onto the IRSD. Place a 6 cm acrylic phantom on the cassette. Position a radiation probe (10 square cm) on top of the phantom. Align the probe position with the AEC sensor at front center on the IRSD. Use the light field and collimate the x-ray field to the approximate size of the probe.
2. Set the unit for an Auto-kV exposure using the Large focal spot and the Molybdenum filter. Make 10 exposures and record the milliroentgen readings for each exposure.
3. Calculate the average milliroentgen reading. Subtract each actual reading from the average. Square each difference. Add the squares and divide their sum by 9. Take the square root of the result.
4. Divide the number obtained in Step 3 by the average milliroentgen reading. The quotient, called the coefficient of variation, must be less than 0.05.

2.5 Reproducibility (Auto-Filter Mode) Check

The following test verifies that the automatic exposure control system is reproducible in the Auto-Filter exposure mode. Failure to meet this performance test indicates the need to check the calibration of the Automatic Exposure Control System.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Mount a cassette holder (with an empty cassette) onto the IRSD. Place a 6 cm acrylic phantom on the cassette. Position a radiation probe (10 square cm) on top of the phantom. Align the probe position with the AEC sensor at front center on the IRSD. Use the light field and collimate the x-ray field to the approximate size of the probe.
2. Set the unit for an Auto-Filter exposure using the Large focal spot. Make 10 exposures and record the milliroentgen readings for each exposure.
3. Calculate the average milliroentgen reading. Subtract each actual reading from the average. Square each difference. Add the squares and divide their sum by 9. Take the square root of the result.
4. Divide the number obtained in Step 3 by the average milliroentgen reading. The quotient, called the coefficient of variation, must be less than 0.05.

Note …To calculate the coefficient of variation, use the Reproducibility Worksheet (Table 4-2) which sequences the steps to calculate the quotient. Table 4-2 also provides a formula to calculate the quotient using a statistical calculator. Note that the kV and mAs values are not set for this check.

3.0 X-ray and Light Field Compliance

The following checks and adjustments are used to ensure that the alignment of the x-ray field and light field are within the specifications set forth by the FDA, 21 CFR, and the recommendations by the ACR/CDC.

3.1 X-ray Beam Alignment Check and Adjustment

The following paragraphs describe how to adjust the collimator blades to the appropriate field sizes for both the large and small focal spots. Two reference tables are provided for these adjustments (Table 4-4 for large focal spot adjustments, and Table 4-5 for small focal spot adjustments).

WARNING!

Observe all safety precautions while making an X-ray exposure.

3.1.1 X-ray Field Adjustment - Large Focal Spot

The automatic beam limiting device provides five x-ray field sizes, all of which are available when using the large focal spot. The five x-ray field sizes are determined by the size of the various Compression Paddles used for large focal spot exposures (i.e., 18 x 24 cm, 24 x 30 cm). The procedure that follows describes how to adjust the x-ray field to the appropriate sizes for the large focal spot. Refer to Table 4-4.

1. Place a loaded 24 x 30 cm Bucky onto the IRSD. Place a loaded 24 x 30 cm cassette on top of the Bucky. Orient the cassette so that it is centered on the Bucky device, then rotate it 90 degrees. Slide the cassette forward so that it overlaps the chest wall edge by approximately 3 cm (see Figure 4-3).
2. Install the 24 x 30 cm Compression Paddle onto the Compression Device. Lower the Compression Device until the paddle just touches the surface of the cassette on the Bucky.
3. Secure a marker (i.e., coin, solder, etc.) at the front, inside edge of the Compression Paddle to accurately mark the chest wall edge of the IRSD.
4. Set the Host Microprocessor for operation in the Calibration mode (S6, position 4 ON). Select the Collimator Position adjustment mode (S4, position F).

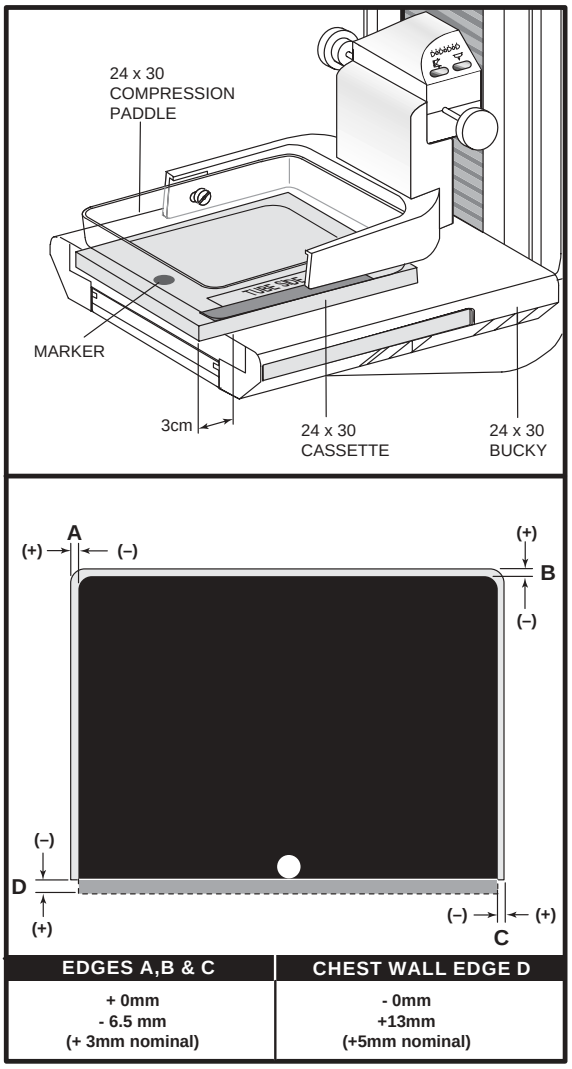


Figure 4-3: X-ray Field Size—24 x 30 cm

5. Set the unit for a Manual mode, Large focal spot exposure at 25 kV, 50 mAs. Make the exposure, remove both cassettes, then develop the films.
6. Check the 24 x 30 cm film on each of the non-chest wall edges for white space. The x-ray field, at each of these edges, MUST NOT exceed the film edge (+0 mm), but must be within 1% of SID (-6.5 mm) from each edge.

7. If any adjustments are necessary, first note the distances required to correct each edge, then press S2 <Select> until the desired collimator blade value displays (i.e., 0 rr #### = 24 x 30 x-ray field, Large focus, rear blade). See Table 4-4 for all collimator blade settings.
8. Press S5 <increase> or S3 <decrease> on the Host to change the value for the selected collimator blade. Note that 10 increments on the display equals approximately 1 mm movement at the film plane for the adjusted blade.
9. Perform the adjustment for each edge requiring change, then repeat the verification exposure. Check both films to ensure that each edge falls within specifications. Repeat the adjustments and verification films as necessary for the 24 x 30 cm field format.

Note …The front collimator blade value will remain the same for all subsequent large focus x-ray field formats. Therefore, enter the 24 x 30 cm front collimator blade value for the remaining large focal spot field sizes.

10. Remove the 24 x 30 cm Bucky device, and replace it with a loaded 18 x 24 cm Bucky device. Place a loaded 18 x 24 cm cassette on top of the Bucky. Orient the cassette so that it is centered on the Bucky device, then rotate it 90. Slide the cassette forward so that it overlaps the chest wall edge by approximately 3 cm (Figure 4-4).
11. Install the 18 x 24 cm Compression Paddle onto the Compression Device. Lower the Compression Device until the paddle just touches the surface of the cassette on the Bucky.
12. Secure a marker (i.e., coin, solder, etc.) at the front, inside edge of the Compression Paddle to accurately mark the chest wall edge of the IRSD.
13. Set the unit for a Manual mode, Large focal spot exposure at 25 kV, 50 mAs, then make the exposure. Remove both cassettes and develop the films.

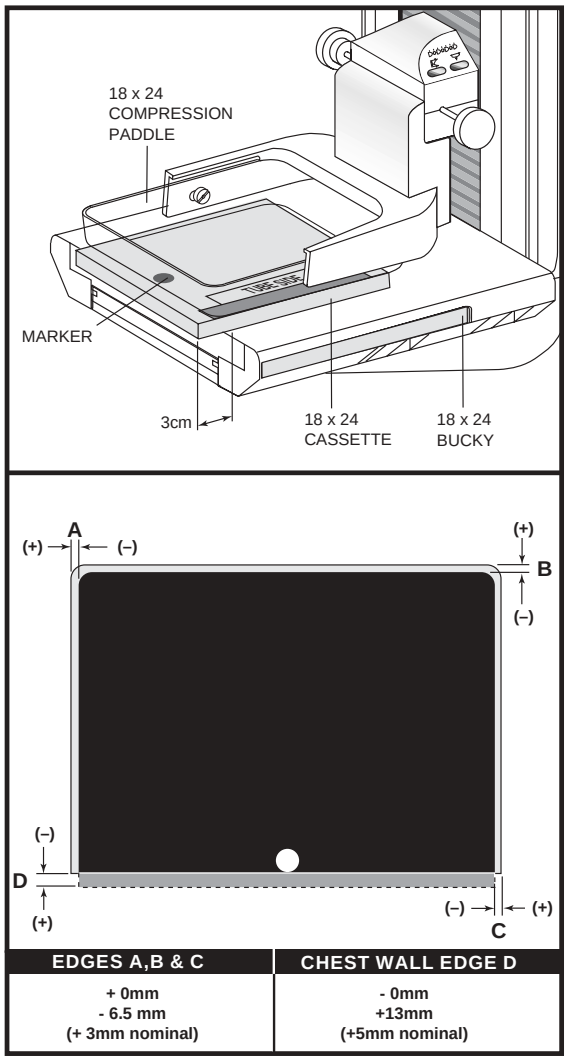


Figure 4-4: X-ray Field Size—18 x 24 cm

14. Check the 18 x 24 cm film (from the Bucky) on each of the non-chest wall edges for white space. The x-ray field, at each of these edges, MUST NOT exceed the film edge (+0 mm), but must be within 1% of SID from each edge (-6.5 mm).
15. Check the second 18 x 24 cm film for proper chest wall edge overlap. The x-ray field, at the edge with the marker, MUST minimally reach the chest wall edge (-0 mm), but MUST NOT exceed the coin marker by more than +13 mm (+5 mm nominal).

16. If any adjustments are necessary, first note the distances required to correct each edge, then press S2 <Select> until the desired collimator blade value displays (i.e., 1 rr #### = 18 x 24 x-ray field, Large focus, rear blade). See Table 4-4 for all collimator blade settings.
17. Press S5 <increase> or S3 <decrease> on the Host to change the value for the displayed collimator blade. Note that 10 increments on the display equals approximately 1 mm movement at the film plane for the adjusted blade.
18. Perform this for each edge requiring change, then repeat the exposure. Check both films to ensure that each edge falls within the specification stated. Repeat the adjustments and verification films as necessary for the 18 x 24 cm field format.
19. Remove the 18 x 24 cm Bucky. Position a loaded 24 x 30 cm cassette on the IRSD, and center it laterally. Pull the cassette forward so that its front edge overlaps the chest wall edge of the IRSD by approximately 3 cm. See Figure 4-5.
20. Install the 15 cm format Compression Paddle, then lower the Compression Device so that the Paddle just touches the cassette. Place markers (i.e., coins, solder, etc.) at each inside edge of the Compression Paddle and secure them in place.
21. Set the unit for a Manual mode, Large focal spot exposure at 25 kV, 50 mAs, then make the exposure. Remove the cassette and develop the film.
22. Check the film on each of the non-chest wall edges for white space. The x-ray field, at each of these edges, MUST BE within 1% of SID from each edge (±6.5 mm).
23. Check the film for proper chest wall edge overlap. The x-ray field MUST minimally reach the chest wall edge (-0 mm), but MUST NOT exceed the marker by more than 13 mm (+5 mm nominal).
24. If any adjustments are necessary, first note the distances required to correct each edge, then press S2 <Select> until the desired collimator blade value displays (i.e., 2 rr #### = 15 cm x-ray field, large focus, rear blade). See Table 4-4 for all collimator blade settings.
25. Press S5 <increase> or S3 <decrease> on the Host to change the value for the displayed collimator blade. Note that 10 increments on the display equals approximately 1 mm movement at the film plane for the adjusted blade.
26. Perform this for each edge requiring change, then repeat the exposure. Repeat the adjustments and verification films as necessary for the 15 cm field format.
27. Perform steps 18 through 26 for the 10 cm x-ray field size, then again for the 7.5 cm x-ray field size. ALWAYS use the large focal spot for all exposures. BE SURE to enter the exact value for the front collimator blade for all field sizes.

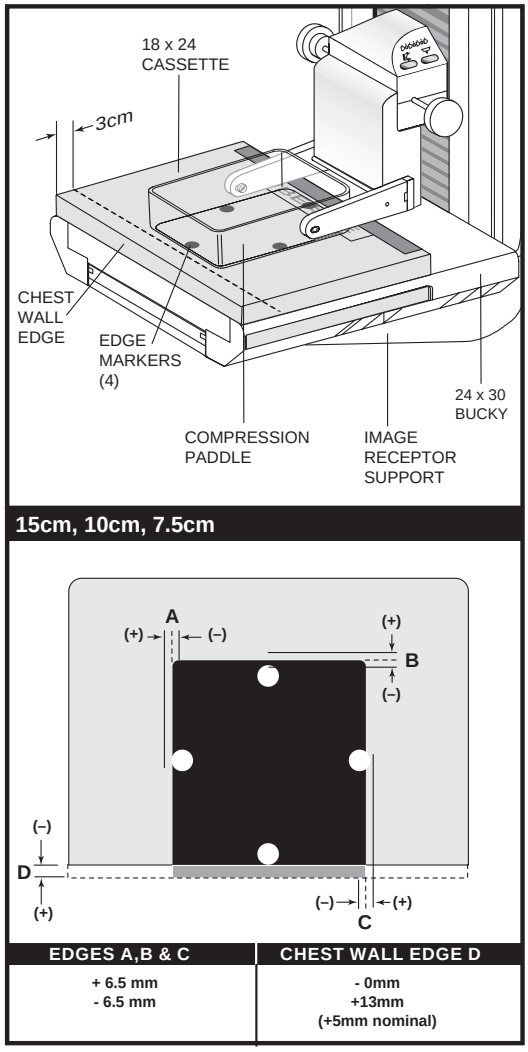


Figure 4-5: X-ray Field Size—15 cm, 10 cm, and 7.5 cm Formats

Table 4-4: X-ray Field Adjustment Matrix—Large Focal Spot

HOST DISPLAY	SELECTED FIELD SIZE	FOCAL SPOT	BLADE ADJUSTMENT	FINAL VALUE
0 rr ####	24 x 30 cm - Field	Large Spot	Rear Blade (x-ray field)	
0 lt ####	24 x 30 cm - Field	Large Spot	Left Blade (x-ray field)	
0 rt ####	24 x 30 cm - Field	Large Spot	Right Blade (x-ray field)	
0 ft ####	24 x 30 cm - Field	Large Spot	Front Blade (x-ray field)	
1 rr ####	18 x 24 cm - Field	Large Spot	Rear Blade (x-ray field)	
1 lt ####	18 x 24 cm - Field	Large Spot	Left Blade (x-ray field)	
1 rt ####	18 x 24 cm - Field	Large Spot	Right Blade (x-ray field)	
1 ft ####	18 x 24 cm - Field	Large Spot	Front Blade (x-ray field)	
2 rr ####	15 x 15 cm - Field	Large Spot	Rear Blade (x-ray field)	
2 lt ####	15 x 15 cm - Field	Large Spot	Left Blade (x-ray field)	
2 rt ####	15 x 15 cm - Field	Large Spot	Right Blade (x-ray field)	
2 ft ####	15 x 15 cm - Field	Large Spot	Front Blade (x-ray field)	
3 rr ####	10 x 10 cm - Field	Large Spot	Rear Blade (x-ray field)	
3 lt ####	10 x 10 cm - Field	Large Spot	Left Blade (x-ray field)	
3 rt ####	10 x 10 cm - Field	Large Spot	Right Blade (x-ray field)	
3 ft ####	10 x 10 cm - Field	Large Spot	Front Blade (x-ray field)	
4 rr ####	6 x 7.5 cm - Field	Large Spot	Rear Blade (x-ray field)	
4 lt ####	6 x 7.5 cm - Field	Large Spot	Left Blade (x-ray field)	
4 rt ####	6 x 7.5 cm - Field	Large Spot	Right Blade (x-ray field)	
4 ft ####	6 x 7.5 cm - Field	Large Spot	Front Blade (x-ray field)	

Note …To access Host Display 6 and 7, make sure the 18 x 24 cm Bucky is installed, and Small Focal Spot is selected.

3.1.2 Light Field Adjustment - Small Focal Spot

The system requires that the light field for each collimation size be adjusted separately for the Small focal spot, before adjusting the small focus x-ray fields. Refer to Table 4-5. The X-ray to Light Field Template (3-405-8005) is required to perform this procedure.

1. Press the Light Field button and observe illuminated area on the X-ray to Light Field Template (9-060-0140).
2. If any adjustments are necessary press S2 <Select> (on the Host Microprocessor Board) until the desired collimator blade value displays (i.e., 7 rr #### = 18 x 24 cm light field, small focus, rear blade). See Table 4-5 for all collimator blade settings.
3. Press S5 <increase> or S3 <decrease> on the Host to change the value for the displayed collimator blade under adjustment. Note that 10 increments on the display equals approximately 1 mm movement at the film plane for the adjusted blade.

3.1.3 X-ray Field Adjustment - Small Focal Spot

Perform these steps only after adjusting the collimator blades for the small focal spot light field formats. Refer to Table 4-5. The X-ray to Light Field Template (3-405-8005) and intensifying screen material are required to perform this procedure.

1. Install the X-ray to Light Field Alignment Template (9-060-0140). Insure correct alignment on the C-arm assembly before proceeding.
2. Collimator blade positions for the small X-ray field are 11, 12, 13, 14, and 15 on the Host Display. Referencing the Intensifying Screen Template Fixture, adjust collimator sizes for the small focal spot as listed below and labeled small on your template.

Ap. Code	FS/SIZE	Ap. Code	FS/SIZE
X 15	Small 6 x 7.5	0	Large 24 x 30
X 12	Small 18 x 24	1	Large 18 x 24
X 13	Small 15 x 15	2	Large 15 x 15
X 14	Small 10 x 10	3	Large 10 x 10
X 11	Small 18 x 24	4	Large 6 x 7.5

3. The X-ray field must be adjusted to fall within the 5 mm guidelines portrayed on the template for the X-ray size being calibrated.
4. After completing the calibration, remove the template and install a Bucky assembly with the appropriate image receptor (cassette) installed.
5. Set the system for Manual 22 kV, 16 mAs exposures.
6. Expose and develop X-ray films for each required spot size and collimator opening. Measure the films in accordance with the X-ray field size.
7. Record the actual values in Table 4-5.

Table 4-5: X-ray Field Adjustment—Small Focal Spot

HOST DISPLAY	SELECTED FIELD SIZE	FOCAL SPOT	BLADE ADJUSTMENT	FINAL VALUE
6 rr ####	18 x 24 cm - Field	Small Spot	Rear Blade (light field)	
6 lt ####	18 x 24 cm - Field	Small Spot	Left Blade (light field)	
6 rt ####	18 x 24 cm - Field	Small Spot	Right Blade (light field)	
6 ft ####	18 x 24 cm - Field	Small Spot	Front Blade (light field)	
7 rr ####	18 x 24 cm - Field	Small Spot	Rear Blade (light field)	
7 lt ####	18 x 24 cm - Field	Small Spot	Left Blade (light field)	
7 rt ####	18 x 24 cm - Field	Small Spot	Right Blade (light field)	
7 ft ####	18 x 24 cm - Field	Small Spot	Front Blade (light field)	
8 rr ####	15 x 15 cm - Field	Small Spot	Rear Blade (light field)	
8 lt ####	15 x 15 cm - Field	Small Spot	Left Blade (light field)	
8 rt ####	15 x 15 cm - Field	Small Spot	Right Blade (light field)	
8 ft ####	15 x 15 cm - Field	Small Spot	Front Blade (light field)	
9 rr ####	10 x 10 cm - Field	Small Spot	Rear Blade (light field)	
9 lt ####	10 x 10 cm - Field	Small Spot	Left Blade (light field)	
9 rt ####	10 x 10 cm - Field	Small Spot	Right Blade (light field)	
9 ft ####	10 x 10 cm - Field	Small Spot	Front Blade (light field)	
10 rr ####	6 x 7.5 cm - Field	Small Spot	Rear Blade (light field)	
10 lt ####	6 x 7.5 cm - Field	Small Spot	Left Blade (light field)	
10 rt ####	6 x 7.5 cm - Field	Small Spot	Right Blade (light field)	
10 ft ####	6 x 7.5 cm - Field	Small Spot	Front Blade (light field)	
11 rr ####	18 x 24 cm - Field	Small Spot	Rear Blade (x-ray field)	
11 lt ####	18 x 24 cm - Field	Small Spot	Left Blade (x-ray field)	
11 rt ####	18 x 24 cm - Field	Small Spot	Right Blade (x-ray field)	
11 ft ####	18 x 24 cm - Field	Small Spot	Front Blade (x-ray field)	
12 rr ####	18 x 24 cm - Field	Small Spot	Rear Blade (x-ray field)	
12 lt ####	18 x 24 cm - Field	Small Spot	Left Blade (x-ray field)	
12 rt ####	18 x 24 cm - Field	Small Spot	Right Blade (x-ray field)	
12 ft ####	18 x 24 cm - Field	Small Spot	Front Blade (x-ray field)	
13 rr ####	15 x 15 cm - Field	Small Spot	Rear Blade (x-ray field)	
13 lt ####	15 x 15 cm - Field	Small Spot	Left Blade (x-ray field)	
13 rt ####	15 x 15 cm - Field	Small Spot	Right Blade (x-ray field)	
13 ft ####	15 x 15 cm - Field	Small Spot	Front Blade (x-ray field)	
14 rr ####	6 x 10 cm - Field	Small Spot	Rear Blade (x-ray field)	
14 lt ####	6 x 10 cm - Field	Small Spot	Left Blade (x-ray field)	
14 rt ####	6 x 10 cm - Field	Small Spot	Right Blade (x-ray field)	
14 ft ####	6 x 10 cm - Field	Small Spot	Front Blade (x-ray field)	
15 rr ####	6 x 7.5 cm - Field	Small Spot	Rear Blade (x-ray field)	
15 lt ####	6 x 7.5 cm - Field	Small Spot	Left Blade (x-ray field)	
15 rt ####	6 x 7.5 cm - Field	Small Spot	Right Blade (x-ray field)	
15 ft ####	6 x 7.5 cm - Field	Small Spot	Front Blade (x-ray field)	

3.2 Light Field Illuminance Check and Adjustment

Intensity and consistency of the Light Field is checked by performing the following procedure.

1. Place a light meter probe at position "A" (Figure 4-6) on the IRSD with its sensor facing up.
2. Take a background light reading, with the light field lamp OFF, and record the results. Take a light reading with the light field lamp ON and record the results.
3. Convert both readings to lux values (use the conversion table on the meter or in the meter manual). Subtract the background lux value from the light field lux value and record the difference.
4. Repeat this illuminance test for the remaining positions ("B", "C", and "D" in Figure 4-6).

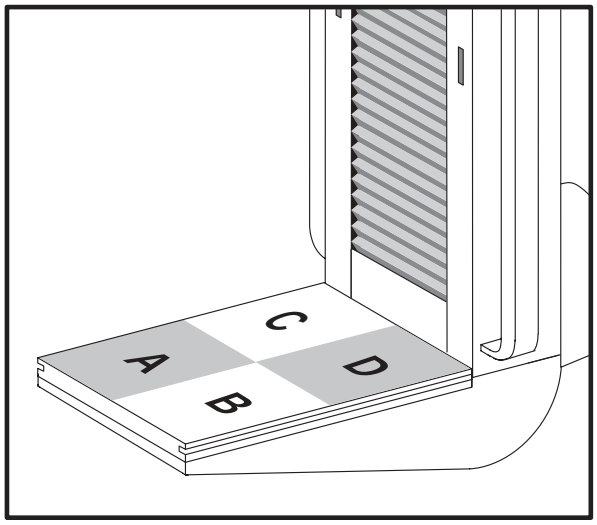


Figure 4-6: Probe Locations—Light Field Illuminance

5. The difference between the background reading and the illuminated reading (in any quadrant) must be 160 lux or greater.
6. If necessary, loosen the two screws that secure the lamp socket to the lamp cradle (Figure 4-7). Increase the light field illuminance by adjusting the lamp position within the cradle. Rotate the lamp and socket together (clockwise or counterclockwise) so that the lamp filament is parallel with the plane of the mirror. Tighten the screws, replace the tubehead cover, then repeat the test.
7. Verify that the length to width ratio of the light field is not altered.

Note …The lamp socket mounting screws are metric.

8. If the check still fails, replace the lamp and repeat the entire check. When complete, perform the light field alignment.

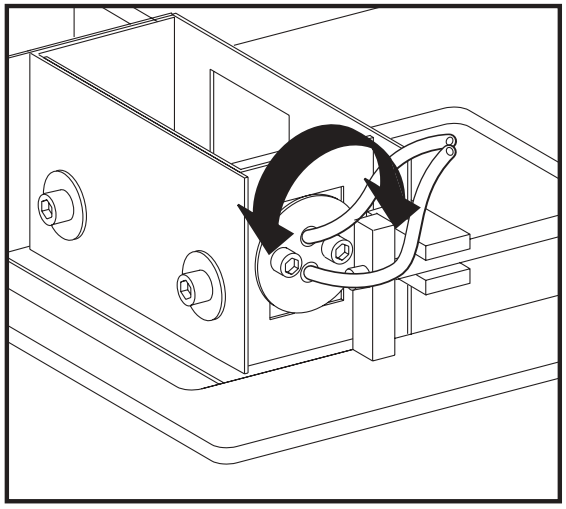


Figure 4-7: Adjustment—Light Field Illuminance

3.3 Light Field Alignment Check and Adjustment

The X-ray to Light Field Template (3-405-8005) and intensifying screen material are required to perform this procedure.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Remove Bucky device from IRSD and the compression paddle from the C-arm.
2. Position X-ray to Light Field Template (3-405-8005) on the breast tray (template will self align when positioned correctly as outlined). Position intensifying screen material under template such that the entire artwork appears on the screen.
3. Adjust the left and right, front and rear borders of the light field by loosening the two screws holding the rear panel to the lamp cradle (A). Move the rear panel left (to move the field to the right), or right (to move the field to the left). Refer to Figure 4-8.
4. Adjust the front/back borders of the light field by loosening the two screws holding the lamp socket to the cradle (C). Move the socket up (to move the field forward), or down (to move the field rearward). To achieve front to back, it may necessary to rotate lamp socket.
5. To adjust the overall field size, loosen the screws holding the right panel to the lamp cradle (B). Move the right panel forward (to increase field size), or rearward (to decrease field size).
6. After any adjustment, tighten any loose hardware, then press the light field button. Repeat the adjustments (steps 6, 7, and 8) as necessary to align the light field to the 18 x 24 cm grid.

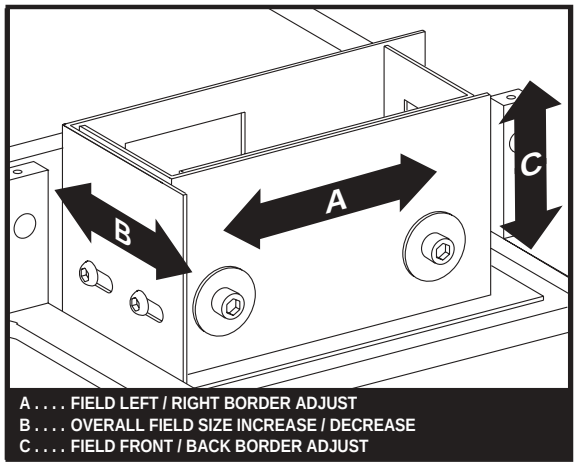


Figure 4-8: Adjustment—Light Field Lamp

3.4 Light Field Edge Contrast Check

This check ensures the contrast of the lighted x-ray field complies to the performance standard set forth by FDA 21 CFR Subchapter J. Always perform this test with the ambient light reduced (darken the room). The following equipment is required for this test:

- Light Detector Model 268P
- Light meter (UDT Instruments, Model 351)
- Aluminum Aperture, 1 mm diameter (or equivalent)

1. Place the probe of a light detector on the IRSD and center it. Place the aluminum aperture directly on the probe. Position it so that the aperture is centered on the probe's sensor. Turn the room lights OFF and record the ambient light reading as IA.
2. Place the light detector in area "A" on the IRSD (see Figure 4-9). Orient the center of the probe 3 mm from the edge of the defined light field toward the center of the field (I1). Collimate the light probe so that only a 1 square centimeter area (near the center) is visible.
3. Press the light field button and record the inside lux value (I1). Move the probe 3 mm from the edge of the defined light field away from the center of the field. Reposition the aluminum filter, press the light field switch, then record the outside lux reading (I2).
4. Subtract both edge readings from the ambient reading and record each of the differences:
   (IA - I1 = D1 and IA - I2 = D2).
5. Divide the inside difference by the outside difference and record the ratio: (D1 / D2 = R).
6. Repeat the procedure for the remaining light field edges. Place the light meter probe at positions B, C, and D for these checks. A contrast ratio less than 4 at any edge is cause for rejection.

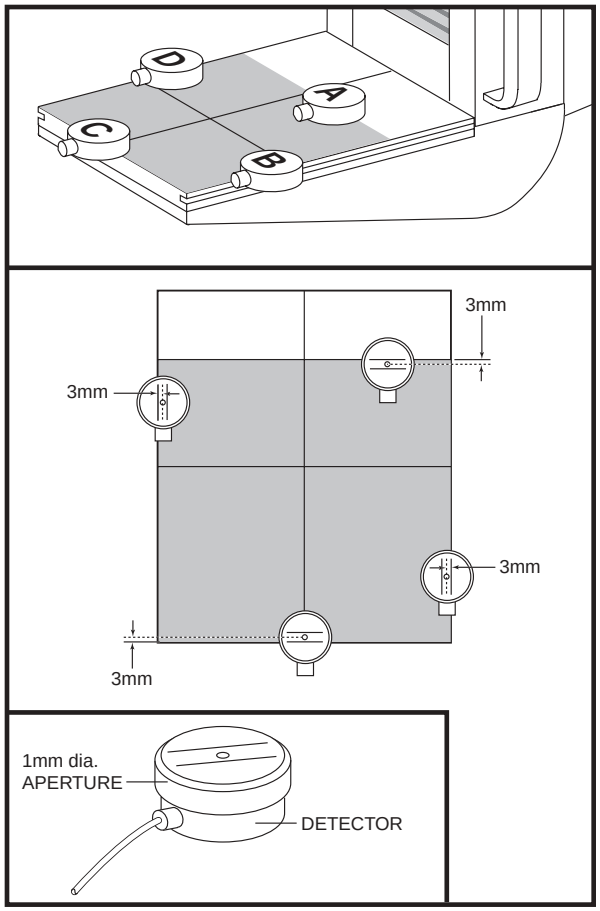


Figure 4-9: Check—Light Field Edge Contrast

4.0 System Performance

The following checks verify performance of the Bucky device motor drive circuitry, and the automatic exposure termination circuitry.

4.1 M-IV Bucky Device (Linear) Performance Check

Perform this performance check after servicing the M-IV style Linear Bucky device, or before utilization of a new Linear Bucky device. This procedure requires the user to make exposures to check for grid lines on the developed film. Grid lines are typically visible under the following conditions: 1) Long exposures (grid moving too fast) or 2) Short exposures (grid moving too slow).

Mount the 18 x 24 cm Bucky device on the IRSD. Be sure the Bucky's electrical connection is made. This procedure requires exposing and developing films. It will be necessary to place attenuation between the tubehead and the Bucky for these tests.

WARNING!

Observe all safety precautions while making X-ray exposure.

Note …Use the same Bucky device, cassette, and film type for all exposures.

1. Rotate the C-arm to 0°. Set the unit for an Auto-Time, 25 kV exposure, Large spot, Normal density. Select the Film Type being used.
2. Place a loaded cassette in the Bucky device, then place 2 cm of B.E.M. (or P.M.M.A. acrylic) on the Bucky Device. Hold the attenuation in place with the Compression Device.
3. Verify a low mAs reading is obtained (nominally between 12 and 20 mAs, dependent on film speed). If the mAs reading is above or below the specified range, add attenuation to increase mAs, or remove attenuation to decrease mAs.
4. Reload the Bucky (using the same cassette and film type), and repeat the exposure. Verify that the mAs falls within the specified range. If it does, remove the cassette and develop the film. Verify the absence of grid lines in the developed film.
5. Place 5 cm of B.E.M. (or P.M.M.A. acrylic) on the Bucky and hold it in place with the paddle. Reload the same cassette with the same film type, then load it into the same Bucky.
6. Make an exposure using the technique factors from step #1. Verify a high mAs reading is obtained (nominally between 250 and 350 mAs, dependent on film speed). If the mAs reading is above or below the specified range, add attenuation to increase mAs, or remove attenuation to decrease mAs.
7. Reload the Bucky (using the same cassette and film type), and repeat the exposure. Verify that the mAs falls within the specified range. If it does, remove the cassette and develop the film. Verify the absence of grid lines in the developed film.
8. Repeat steps #1 through #7 with the C-arm rotated to -90° (grid travel in the direction of gravitational pull). Verify the absence of grid lines on the developed film for all exposures. Repeat the entire procedure for the 24 x 30 cm Bucky Device.
9. Repeat steps #1 through #7 with the C-arm rotated to +90° (grid travel against the direction of gravitational pull). Verify the absence of grid lines on the developed film for all exposures. Repeat the entire procedure for the 24 x 30 cm Bucky Device.
10. If grid lines are present on any exposure, replace with a new Linear Bucky device and repeat this procedure.

4.2 M-IV Bucky Device (HTC Grid) Performance Check

Perform this performance check after servicing the M-IV style HTC Bucky device, or before utilization of a new HTC Bucky device. This procedure requires the user to make exposures to check for grid patterns on the developed film, and error codes.

Note …Grid patterns are typically visible under the following conditions: 1) Exposures in Left or Right MLO 2) Short exposures or incorrect threshold calibration.

Mount the 18 x 24 cm Bucky device on the IRSD. Ensure the Bucky's electrical connection is made. This procedure requires exposing and developing films. It will be necessary to place attenuation between the tubehead and the Bucky for these tests.

WARNING!

Observe all safety precautions while making X-ray exposure.

Note …Use the same Bucky device, cassette, and film type for all exposures.

1. With the C-arm at 0°, set the unit for an Auto-Time, 25 kV exposure, Large spot, Normal density. Select the Film Type being used.
2. Place a loaded cassette in the Bucky device, then place 2 cm of B.E.M. (or P.M.M.A acrylic) on the Bucky Device. Hold the attenuation in place with the compression device.
3. Verify a low mAs reading is obtained (nominally between 12 and 20 mAs, dependent on film speed). If the mAs reading is above or below the specified range, add attenuation to increase mAs, or remove attenuation to decrease mAs.
4. Reload the Bucky (using the same cassette and film type), and repeat the exposure. Verify that the mAs falls within the specified range. If it does, remove the cassette and develop the film. Verify the absence of grid patterns in the developed film.
5. Place 5 cm of B.E.M. (or P.M.M.A. acrylic) on the Bucky and hold it in place with the paddle. Reload the same cassette with the same film type, then load it into the same Bucky.
6. Make an exposure using the technique factors from step #1. Verify a high mAs reading is obtained (nominally between 250 and 350 mAs, dependent on film speed). If the mAs reading is above or below the specified range, add attenuation to increase mAs, or remove attenuation to decrease mAs.
7. Reload the Bucky (using the same cassette and film type), and repeat the exposure. Verify that the mAs falls within the specified range. If it does, remove the cassette and develop the film. Verify the absence of grid patterns in the developed film.
8. Repeat steps #1 through #7 with the C-arm rotated to -90° (grid travel in the direction of gravitational pull). Verify the absence of grid lines on the developed film for all exposures. Repeat the entire procedure for the 24 x 30 cm Bucky Device.
9. Repeat steps #1 through #7 with the C-arm rotated to +90° (grid travel against the direction of gravitational pull). Verify the absence of grid patterns on the developed film for all exposures. Repeat the entire procedure for the 24 x 30 cm Bucky Device.
10. If grid patterns are present on any exposure, replace with a new HTC Bucky device and repeat this procedure.

4.3 Maximum mAs in Auto-Time Mode Performance Check

This check verifies that the system automatically terminates exposures whenever the automatic exposure control circuitry senses that optimum film density cannot be obtained within the 5 second maximum exposure time. To comply, the system must terminate Auto-Time exposures below 5 mAs.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Place a lead blocker on the IRSD so that it blocks the AEC sensors within the IRSD.
2. Set the unit for an Auto-Time exposure at 22 kV, Large focal spot. Set the Density compensation to +5, and select the film type being used.
3. Make an exposure and verify that the post-exposure mAs value is less than 5 mAs and the message "Calculated Exposure Time Exceeds Maximum" appears.
4. Verify that the unit displays a caution that informs the user that the calculated exposure has exceeded the maximum. Try to make another exposure before resetting the unit and verify that x-ray generation is prevented.
5. Clear the message by selecting RESET. Repeat the test at 34 kV, and verify that the same caution appears in the message area.

4.4 System Level Functional Check

This check verifies system functionality.

1. Apply power to the system. Verify the display works, and power is applied to Gantry. Check console display for error messages.
2. Set unit for a short exposure (25 kV, 3 mAs, Manual Mode, Large Focal Spot). Take exposure.
3. If no problems found with exposure, return unit to service.

4.5 Optical Density (Users Preference) Verification

This procedure verifies that the system falls within the users preference for optical density.

1. Install the jumper into the banana jack on the High Voltage Multiplier. Remove any meter, scope, or probe from the machine that was used in any procedures prior to beginning this verification.
2. Install the HTC Bucky device, with a loaded cassette, on the IRSD. For units that do not have the HTC Bucky device option, install the linear Bucky device.
3. Place the ACR Phantom on the IRSD, centered laterally, and positioned 1 cm back from the chest wall edge.
4. Move the AEC Detectors so that they are directly under the ACR Phantom.
5. Set the unit for an exposure using the default exposure mode. Make an exposure.
6. Remove the cassette and develop the film.
7. Check the film's optical density and verify that it is at the mean optical density as required by the site.
8. If the optical density of the film is not within the limits stated in step 7, perform the AEC Calibration procedures as per Chapter 3, Section 5.0.

5.0 X-ray Shielding Compliance

Lead shielding in the x-ray tube housing, and in the lower tubehead enclosure, minimizes leakage radiation. The IRSD and the space behind the AEC sensor also incorporate lead shielding. The following procedures check the shielding performance of the IRSD and the tubehead.

5.1 IRSD Leakage Check

This check is performed at the factory and is not required at installation. However, it will be necessary to perform this check after repairing or replacing the IRSD.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Connect a radiation scatter probe (100 square cm) to the readout/logic module of a radiation rate meter. Set the meter's operating mode to read in mR/hr. Place the readout/logic module so that it can be viewed from behind the radiation shield.
2. Mount an 18 x 24 cm Bucky to the IRSD. Place a 1/16 inch thick (1.6 mm) sheet of lead with a 5 inch (12.7 cm) diameter hole in it on the IRSD. Slide this lead sheet to position the hole at the position marked "A" (Figure 4-10). Collimate the x-ray field to the 18 x 24 cm field size.
3. Position the probe beneath the IRSD relative to the center of the hole in the lead sheet. Raise or lower the support stand until the probe is exactly 5 centimeters below the bottom of the tray structure. Face the probe's detector surface toward the x-ray source.
4. Apply power to the unit. Set the system for a Manual mode exposure at 39 kV, 220 mAs, using the Large focal spot.
5. Make an exposure and record the mR reading. If the reading exceeds 0.05 mR, corrective action is indicated.
6. Repeat steps 2 through 5 for positions "B", "C", and "D" in Figure 4-10.
7. Mount a 24 x 30 cm Bucky on the IRSD. Repeat steps 2 through 6 for positions "E", "F", "G" and "H" in Figure 4-10. Replace any image receptor holder if there are any readings above 0.05 mR. Ensure x-ray field size is 24 x 30 cm.

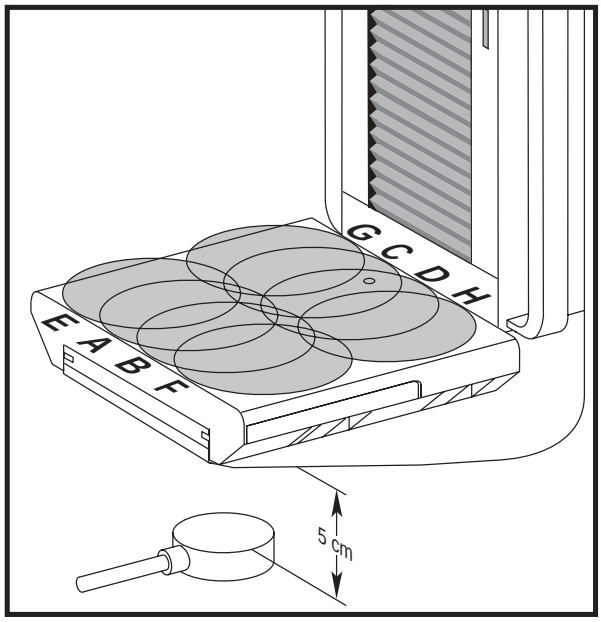


Figure 4-10: Check—IRSD Shielding

5.2 X-ray Tubehead Leakage Check

This check is performed at the factory and is not required at installation. However, it will be necessary to perform this check after repair or replacement of the tubehead housing or the lower tubehead cover.

WARNING!

Observe all safety precautions while making an X-ray exposure.

1. Block the tubehead window with approximately 4 x 4 cm lead shield/blocker.
2. Connect a radiation scatter probe (100 square cm) to the readout/logic module of a radiation rate meter. Set the meter's operating mode to read in milliroentgens per hour (mR/Hour). Place the readout/logic module so that it can be viewed from behind the radiation shield
3. Use fixtures to hold the probe in position with relation to the tubehead as shown in Figure 4-11. Position the probe at location "A". Make sure the distance between the probe and the focal spot (source) is exactly 1 meter (39 3/8 inches).
4. Apply power to the unit. Set the system for a Manual mode exposure at 39 kV, 220 mAs, using the Large focal spot. Make an exposure and record the mR reading.
5. Make exposures, using the same technique factors, for positions "B" through "H" (Figure 4-11). Record each mR reading. For position "H", rotate the C-arm to position the probe directly behind the tubehead. Be sure the distance between the probe and the focal spot remains exactly one meter for each measurement position.

Note …Any reading above 45.0 mR is unacceptable.

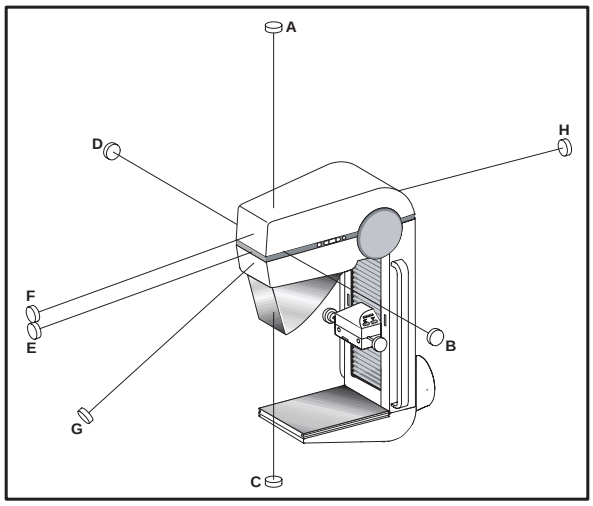


Figure 4-11: Check—Tubehead Shielding

6.0 Error Code Displays

The M-IV control console displays error codes using a two digit, base ten numeric system. Table 4-6 describes each of the M-IV error codes and messages that appear on the Run Mode screen.

Table 4-6: Error Codes

MESSAGE	DESCRIPTION	ORIGIN
Premature Release of Exposure Switch	Exposure switch released early.	Operator
Exposure Terminated by back up timer	Exposure time required exceeded software back up time. (500 mAs back up timer)	Generator Microprocessor
Calculated exposure time exceed back up time	Auto Time, Auto kV, and Auto-Filter modes	Image Receptor Microprocessor
X-ray switches not released after exposure	X-ray switches not released during post exposure routine. Ensure switches are not stuck.	Host Microprocessor
X-ray switches on at power up	X-ray switches are closed during unit power up. Release and ensure switches are not stuck.	Host Microprocessor
Calculated exposure time is lessthan available exposure time	HTC only: minimum time for grid operation is 400 ms	Host Microprocessor
System Error 20	*Rotor Error:* Check tube for overheat; rotor fault, or open thermal switch Check +525 VDC of rotor control board. Check Fuse F21 on DC fuse panel. Check rotor control board EPROM.	Rotor Control
System Error 21	*Start from Host withou x-ray switch fault*	Host Microprocessor
System Error 22	*Tube Arc Fault.* kV arc detected. (Fault diode D19, kV control board)	High Voltage Control
System Error 23	*Tube Overcurrent,* mA level more than 12.5%; higher than set mA level (Fault diode D15, kV control board)	High Voltage Control
System Error 24	*Tube Overvoltage,* kV level more than 12.5% higher than set kV level (Fault diode D14, kV control board)	High Voltage Control
System Error 25	*High Voltage Inverter overcurrent fault* (Fault diode D18, kV control Board)	High Voltage Inverter
System Error 26	*High Voltage Interlock Fault*	High Voltage Inverter
System Error 27	*Filament overcurrent fault.* Filament current levels exceeded 12.5% of the set level. (Fault diode, D2, filament control board.)	mA Control
System Error 28	*Filament overvoltage fault.* Filament voltage levels exceeded 12.5% of the set level. (Fault diode, D3, filament control board.)	mA Control
System Error 29	*Filament grid error.* Grid voltage error detected. (Fault diode D1, filament control board.)	mA Control
System Error 30	*Error in Data from Host.* Error may indicate software lockup with the host.	Image Receptor Microprocessor

Table 4-6: Error Codes (Continued)

MESSAGE	DESCRIPTION	ORIGIN
System Error 31	*Hardware backup timer.* If auto mode, check IR microprocessor. If in manual mode, check generator microprocessor.	Generator Microprocessor
System Error 32	*Software Timeout. Timer greater than 5 seconds.*	Generator Microprocessor
System Error 33	*Image receptor exposure error.* Generator did not receive "Exposure Enable" signal from IR board within 300 ms of "Rotor Okay" signal from motor control board.	Generator Microprocessor
System Error 34	*Focal spot relay fault.*	mA Control
System Error 35	*Tube current is below 10% of expected value.* Check tube current level, calibration, filaments and protective diodes across the filaments.	mA Control
System Error 43	*Measure mAs error.* Error indicates problem with mAs.	High Voltage Control
Bucky Error 50	*Fault detected from the Bucky (non HTC grid)*	Image Receptor Control
Bucky Error 51	*Bucky Fault.* HTC Bucky not communicating with IR microprocessor (serial interface)	Bucky/IR Control
Rotation Switch Error 60	*CCW rotation switch closed.* Check tubehead switches.	CCW Rotation
Rotation Switch Error 61	*CW rotation switch closed.* Check tubehead switches.	CW Rotation
Lamp Switch Error 62	*Lamp switch closed.* Check tubehead switches.	Collimator Lamp
Compression Switch Error 63	*Compression "Up" switch closed.* Check C-Arm and foot switches.	Compression Up
Compression Switch Error 64	Compression "Down" switch closed. Check C-Arm and foot switches.	Compression Down
Compression Switch Error 65	Compression "Release" switch closed. Check C-Arm and foot switches.	Compression Release
C-Arm Vertical Switch Error 66	*C-Arm Vertical "Up" switch closed.* Check C-Arm and foot switches.	C-Arm Up
C-Arm Vertical Switch Error 67	*C-Arm Vertical "Down" switch closed.* Check C-Arm and foot switches.	C-Arm Down
SL II Motion Error 68	*StereoLoc II out of alignment.*	StereoLoc II Stage
Motion Error 69	*C-Arm drive motor communication fault.* Vertical, rotation, and compression drive motors.	C-Arm Drive Motors
Tubehead Error 70	*Motorized collimator error.* Check collimator blade drives.	Tubehead Microprocessor
Tubehead Error 71	*Motorized mirror error.* Check mirror drive.	Tubehead Microprocessor
Tubehead Error 72	*Motorized filter error.* Check filter drive.	Tubehead Microprocessor

Chapter 5: Covers, Panels, Fuses and Jumpers

1.0 Parts Identification

Figures 5-1 and 5-2 show the locations of the covers and panels on the Gantry and the Operator Console.

Legend for Figure 5-1

1. Gantry Door - Left Side
2. Gantry Door - Right Side
3. Front Cover - Left Side
4. Front Cover - Right Side
5. VTA (Vertical Travel Assembly) Frame
6. Upper Rear Panel
7. Lower Rear Panel
8. Upper Tubehead Cover
9. Lower Tubehead Cover
10. Upper Compression Device Cover
11. Lower Compression Device cover

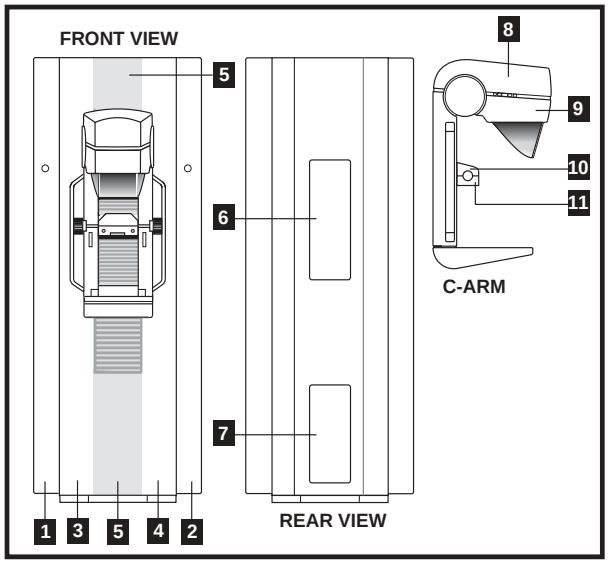


Figure 5-1: Gantry Covers

Legend for Figure 5-2

1. Radiation Shield
2. Operator Control Panel
3. Front Cabinet Panel

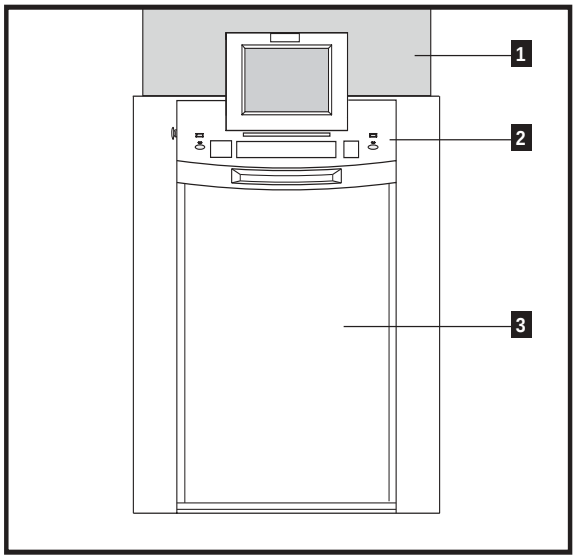


Figure 5-2: Operator Console Covers

2.0 Remove and Replace—Covers

The following paragraphs detail the cover removal procedures for the Operator Console, the Gantry, and the C-arm. Note that instructions for removing the Radiation Shield covers are detailed in Section 2.

2.1 Operator Console Covers

WARNING!

Always remove power before performing any removal or replacement procedure.

Access to the serviceable components and assemblies of the Operator Console are through these covers:

- Operator Control Panel (Item 1, Figure 5-3)
- Front Cabinet Panel (Item 2, Figure 5-3)

Remove the Front Cabinet Panel

1. Remove the decorative hole covers from the bottom corners of the front panel to access the mounting hardware (Item 3, Figure 5-3). Use care not to damage the covers during removal.
2. Disengage the one-quarter turn fasteners that secure the front panel to the console frame.
3. Pull the bottom of the panel away from the frame so that the top edge clears the locating pins.
4. Remove ground lead attached to panel.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

5. Lift the front panel off the Console frame to access the following components:
   - Operator Microprocessor Board
   - Low Voltage Power Supply
   - Operator Console Fuses
   - Floppy Disk Drive

Remove the Operator Control Panel

6. Remove the two screws (Item 4, Figure 5-3) that fasten the Control Panel to the Console frame.
7. Lift the Control Panel far enough to gain access to the console cables.
8. Disconnect connector JP1 from the Control Panel.
9. Disconnect the Sub Panel Cable Harness Assembly connector located behind and below the LCD Display (Item 5, Figure 5-3).

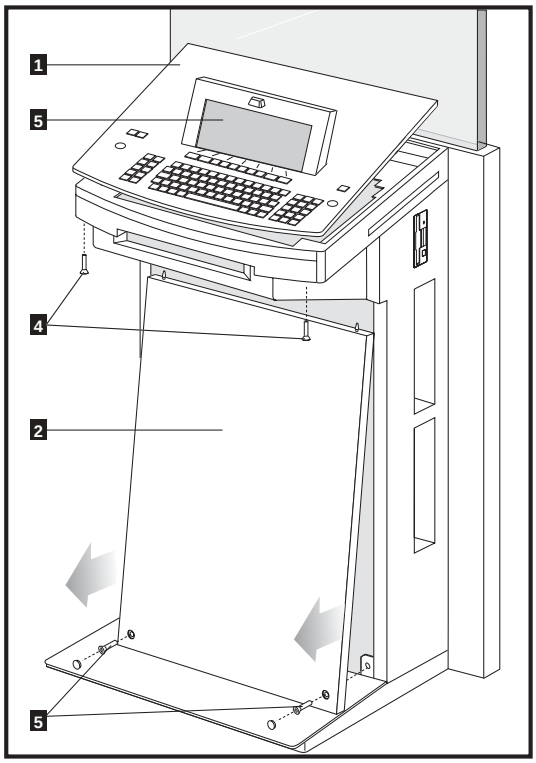


Figure 5-3: Operator Console Covers—Removal

10. Lift the Control Panel off the console. This provides access to the following components:
    - Keyboard
    - Switch Boards
    - AutoFilm ID
    - Floppy Disk Drive
11. Reverse procedures to replace the Operator Control Panel and the Front Cabinet Panel.

2.2 Gantry Covers

WARNING!

Always remove power before performing any removal or replacement procedure.

Access to the serviceable components and assemblies of the Gantry are through these covers:

- Left and Right Side Doors (hinged) (Items 1 and 2, Figure 5-1)
- Left and Right Front Covers (Items 3 and 4, Figure 5-1)
- VTA Frame (Item 5, Figure 5-1)
- Upper Rear Panel (Item 6, Figure 5-1)
- Lower Rear Panel (Item 7, Figure 5-1)

Refer to Figure 5-4 throughout the following:

Left and Right Side Gantry Doors (hinged)

1. To open Left or Right Gantry doors, access the top restraining hardware and release locking mechanism.

Left and Right Front Covers

2. Remove the hardware that fastens the Left Front Gantry cover to the VTA (vertical travel assembly) frame.
3. Pull the cover off the locating pins, then lift it off the frame.
4. Repeat Steps 2 and 3 for the Right Front Gantry Cover.

VTA Frame

5. At top of M-IV Unit, locate two bolts securing top of the VTA frame to Gantry. Remove bolts, spacers and washers.
6. Locate two bolts securing bottom of the VTA frame to the Gantry base. Remove bolts and washers.
7. Pull VTA frame forward on pivot tube to enable access to VTA components. It may be necessary to rotate VTA frame to a horizontal position in order to facilitate access.

Upper Rear Access Panel

8. Remove the mounting hardware that fastens the Upper Rear access panel to the Gantry cover.
9. Lift the upper rear access panel off the unit.

Lower Rear Access Panel

10. Remove the mounting hardware that fastens the Lower Rear access panel to the Gantry cover.
11. Lift the lower rear access panel off the unit.

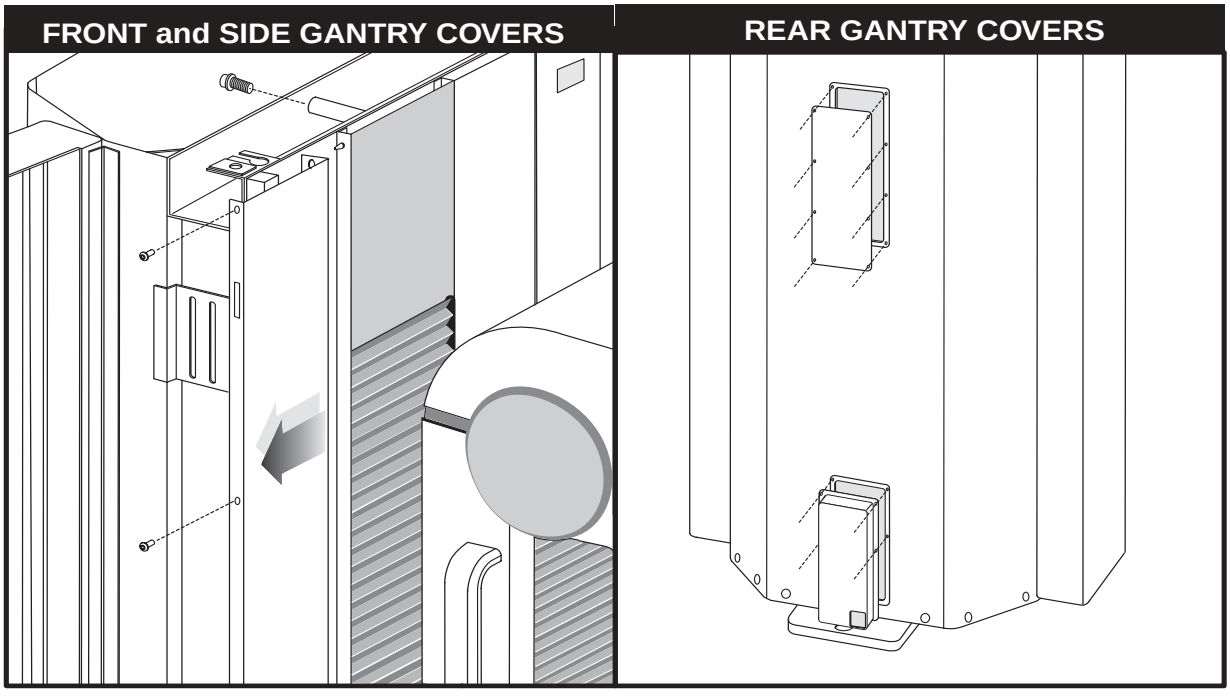


Figure 5-4: Gantry Covers—Removal

2.3 Compression Device Covers

Access to the serviceable components and assemblies of the C-arm are through these covers:

- Upper Compression Device Cover
- Lower Compression Device Cover

CAUTION

Note…The top and bottom Compression Device covers are fastened to the compression bellows. Use care not to damage the bellows when removing these covers.

1. Remove the mounting hardware that fastens the Compression Device covers (top and bottom) to the Compression Device. (See Figure 5-5.)
2. Carefully lift the covers off the compression Device to access the following components:
   - Compression Clutch
   - Compression Clutch brake
   - Compression Drive
   - Compression Brake
   - Compression Paddle Detection Board
3. Disconnect the wiring between the covers and the Compression device, includes 1 ground wire for each cover.
4. Reverse procedures to replace the Compression Device Covers.

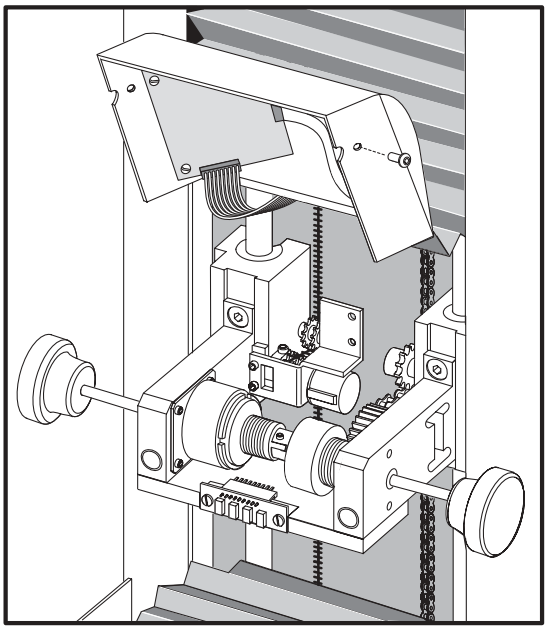


Figure 5-5: Compression Device Covers—Removal

2.4 Tubehead Covers

Access to the serviceable components and assemblies of the Tubehead are through these covers (refer to Figure 5-6 throughout the following):

- Upper Tubehead Enclosure
- Lower Tubehead Enclosure

1. Remove the face shield.
2. Remove the decorative logo covers from either side of the tubehead by pulling them out of their locating holes.
3. Remove the hardware that fastens the lower tubehead cover to the tubehead frame (two rear screws under the decorative logo covers, two front screws in face shield mount).
4. Slide the lower cover down and forward approximately 2 cm, then angle it downward to release.
5. Pull the lower cover off the tubehead to access the following components:
   - Collimator Assembly
   - Light Field / Mirror Assembly
   - Dual Filter Assembly
   - Tubehead Motor Control Board
   - Tubehead Microprocessor Board
   - Tubehead Switch Boards
6. Remove the hardware that fastens the upper tubehead cover to the rear tubehead frame (located under the decorative logo covers.)
7. Remove the hardware that fastens the upper cover to the front mounting bracket (vertical screws under cover).
8. Lift the upper cover off the tubehead to access the following components:
   - X-ray Tube
   - Tubehead Cooling Fan
   - Filament Protection Board
9. Reverse procedures to replace the Tubehead Covers

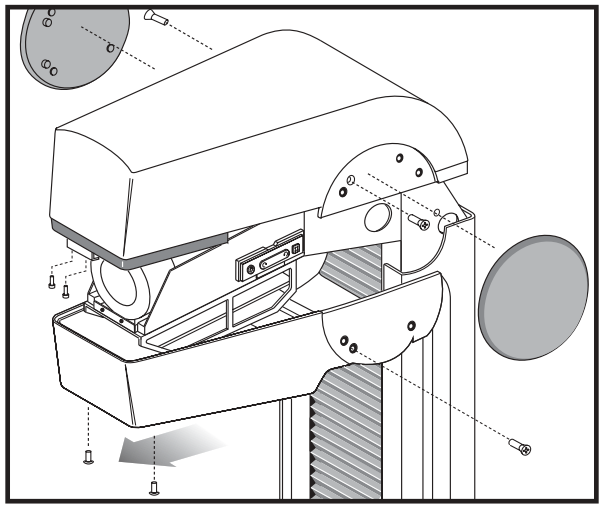


Figure 5-6: Tubehead Covers—Removal

2.5 Image Receptor Support Device (IRSD) Covers

1. Remove the hardware that fastens the IRSD to the C-arm frame (refer to Figure 5-7).

Note…StereoLoc II models, in place of the fastening hardware shown in Figure 5-7, will have two latches located on the rear of the C-Arm sub frame (1 on each side). These latches must be opened prior to removing the IRSD.

2. Pull the IRSD forward to remove it from the C-arm.
3. Remove the IRSD cover to access the following components:
   - IR Microprocessor and Accessory Detect Board
   - AEC Detector Board
   - Bucky Interface Board
4. Set the IRSD down on a secure surface and remove the two screws located on the sides of the IRSD which attach the cover.
5. Disconnect the wiring harness from the C-arm Rotation Switch, and remove the two screws which attach the switch assembly to the IRSD and the IRSD cover. Store the switch assembly safely.
6. Grasp the IRSD firmly while pushing the cover down and forward, taking care to clear the cover support brackets located in the front of the IRSD.
7. Reverse procedures to replace the IRSD.

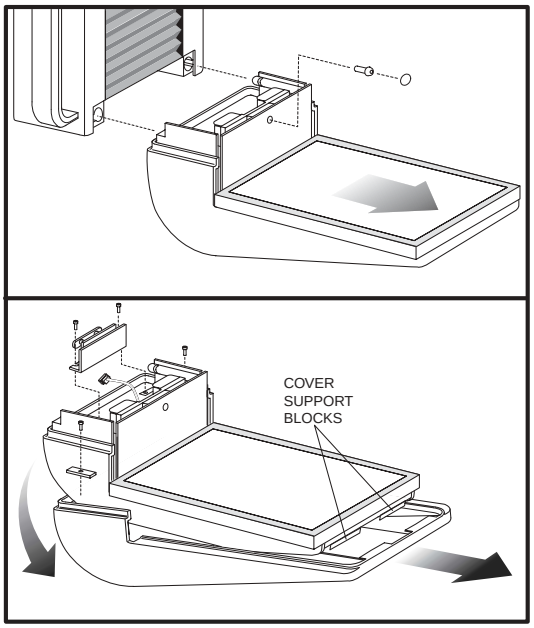


Figure 5-7: IRSD and IRSD Cover—Removal

3.0 Fuses

This sections provides information regarding system fuses, their locations, and their ratings.

3.1 Fuses—Operator Console

Figure 5-8 shows the fuses in the Operator Console. These fuses are attached to the components panel which is accessed by removing the front cover of the Operator Console. Table 5-1 provides each fuse rating and circuit.

Table 5-1: Operator Console Fuse Matrix

FUSE	RATING	CIRCUIT
F1	4 Amp, 250 V	Operator Microprocessor
F2	2 Amp FB	Operator Microprocessor
F3	0.5 Amp, 250 V	Operator Microprocessor
F2	0.5 Amp, 250 V	Operator Microprocessor

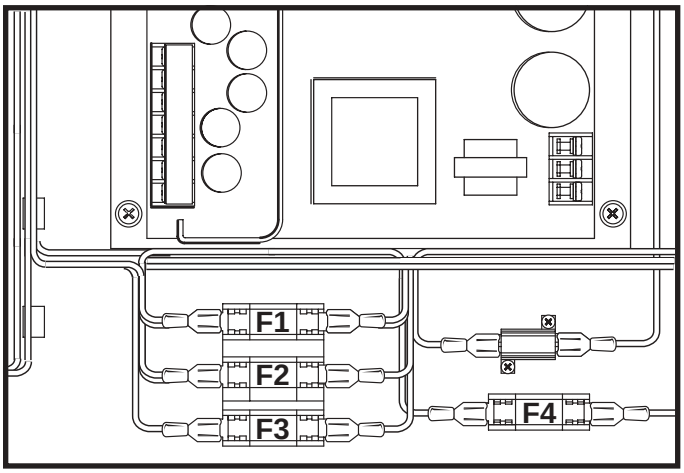


Figure 5-8: Console Fuses

3.2 AC Fuses—Gantry

Figure 5-9 shows the AC fuses on the Fuse Board. The Fuse Board is attached to the Gantry frame and is accessed by opening the right side Gantry door. Table 5-2 provides each fuse rating and circuit.

3.3 DC Fuses—Gantry

Figure 5-10 shows the D.C. rail fuses. These fuses are attached to a fuse panel which is accessed by opening the left side Gantry door. Table 5-3 provides each fuse rating and circuit.

Table 5-2: Gantry A.C. Fuses

FUSE	RATING	CIRCUIT
F1	10 Amp SB, 250 V	+90 VDC
F2	10 Amp SB, 250 V	+90 VDC
F3	2 Amp SB, 250 V	120 VAC (Console LVPS)
F4	2 Amp SB, 250 V	120 VAC (Console LVPS)
F5	10 Amp SB, 250 V	24 VAC (Motor Control)
F6	10 Amp SB, 250 V	24 VAC (Motor Control)
F7	10 Amp SB, 250 V	+28 VDC
F8	10 Amp SB, 250 V	+28 VDC
F9	10 Amp SB, 250 V	Filament
F10	10 Amp SB, 250 V	Filament
F11	5 Amp SB, 250 V	AEC/Bucky
F12	5 Amp SB, 250 V	AEC/Bucky
F13	5 Amp SB, 250 V	+15 VDC
F14	4 Amp SB, 250 V	+15 VDC
F15	5 Amp SB, 250 V	+10 VDC
F16	5 Amp SB, 250 V	+10 VDC
F17	15 Amp SB, 600 V	+525 VDC
F18	15 Amp SB, 600 V	+525 VDC
F19	30 Amp SB, 600 V	+325 VDC
F20	30 Amp SB, 600 V	+325 VDC

Table 5-3: Gantry D.C. Fuse Matrix

FUSE	RATING	CIRCUIT
F21	8 Amp, 600 V	Rotor Rail
F22	25 Amp, 600 V	Power Supply
F23	8 Amp SB, 250 V	Rotor Rail
F24	5 Amp SB, 250 V	Motor Driver
F25	8 Amp, 250 V	Filament

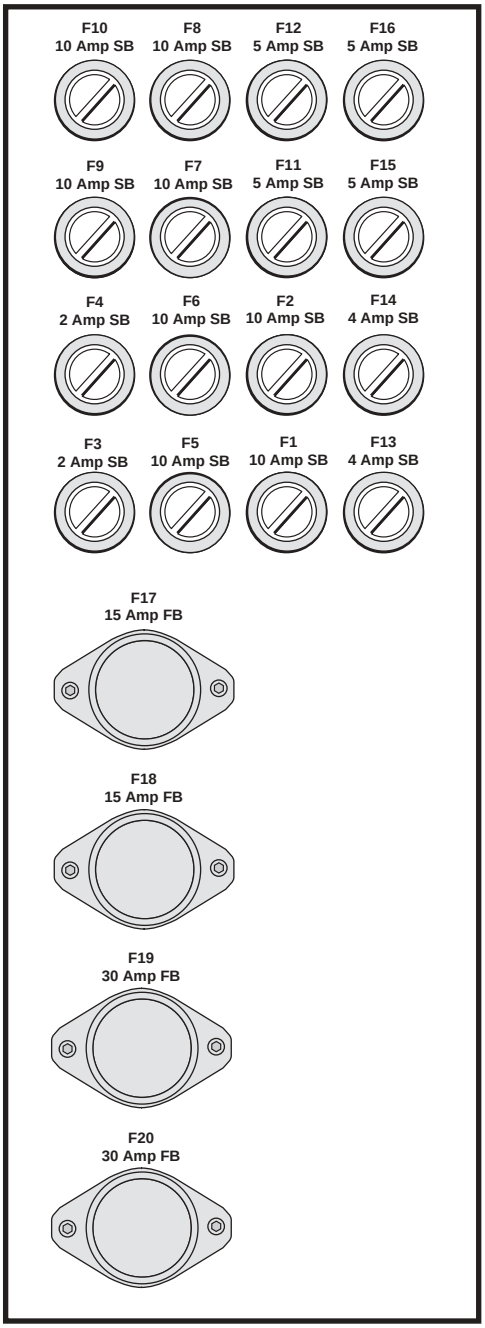


Figure 5-9: Gantry A.C. Fuses

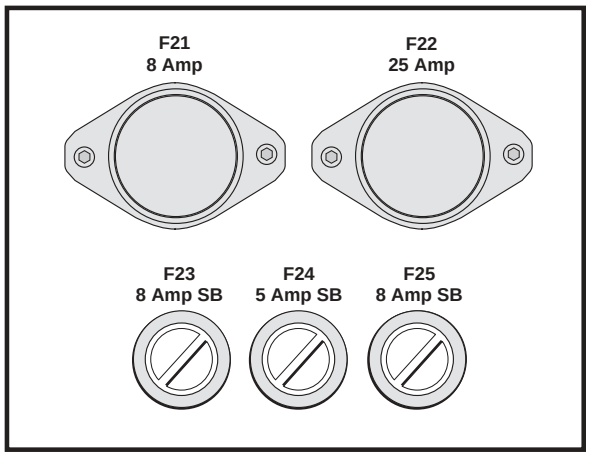


Figure 5-10: Gantry D.C. Fuses

4.0 Jumpers

Table 5-4 and 5-5 provide information regarding circuit board jumper settings.

Table 5-4: Circuit Board Jumper Settings

CIRCUIT BOARD	JUMPER #	JUMPER POSITION
Host Microprocessor Board	J1	pins 1 and 2
Motor/Lamp Control Board	JCJ-32	pins 2 and 3
Motor/Lamp Control Board	J1	pins 1 and 2
Motor/Lamp Control Board	J2	open
Motor/Lamp Control Board	J3	open
Motor/Lamp Control Board	J4	open
Motor/Lamp Control Board	J5	pins 1 and 2
Motor/Lamp Control Board	J6	pins 1 and 2
Motor/Lamp Control Board	J7	pins 1 and 2
Motor/Lamp Control Board	J8	pins 1 and 2
Motor/Lamp Control Board	J9	pins 1 and 2
Image Receptor Microprocessor Board	JP1	open
Image Receptor Microprocessor Board	JP2	pins 1 and 2
VTA Motor Driver Board	WJ8	pins 1 and 2
VTA Motor Driver Board	WJ9	pins 1 and 2
VTA Motor Driver Board	WJ10	pins 1 and 2
VTA Motor Driver Board	WJ11	pins 1 and 2
VTA Motor Driver Board	WJ15	pins 1 and 2
High Voltage Control Board	JP-1 (4)	pins 1 and 2 (all)

Table 5-5: Operator Microprocessor Jumper Settings

JUMPER	FUNCTION	SETTING
JP6	Not Used	N/A
JP7	AutoFilm ID Tones	1 and 2 = Hi
		3 and 4 = Med
		5 and 6 = Lo
JP8	RIS Serial Protocol	1 and 2 = 422
		2 and 3 = 232
JP9	X-ray Tones	1 and 2 = Hi
		3 and 4 = Med
		5 and 6 = Lo

Note…Jumper pins are numbered left-to-right for horizontal orientation, or top-to-bottom for vertical orientation.

Chapter 6: Operator Console Maintenance

1.0 Parts Identification

Figure 6-1 shows the locations of the Operator Console components.

Legend for Figure 6-1

1. Keyboard
2. X-ray and ON/OFF Board
3. AutoFilm ID Assembly
4. Operator Interface Microprocessor
5. Low Voltage Power Supply
6. Fuses
7. Console Display
8. X-ray and Compression Release Board
9. Bar Code Reader Assembly (optional)
10. Floppy Disk Drive
11. Keyboard Illuminator

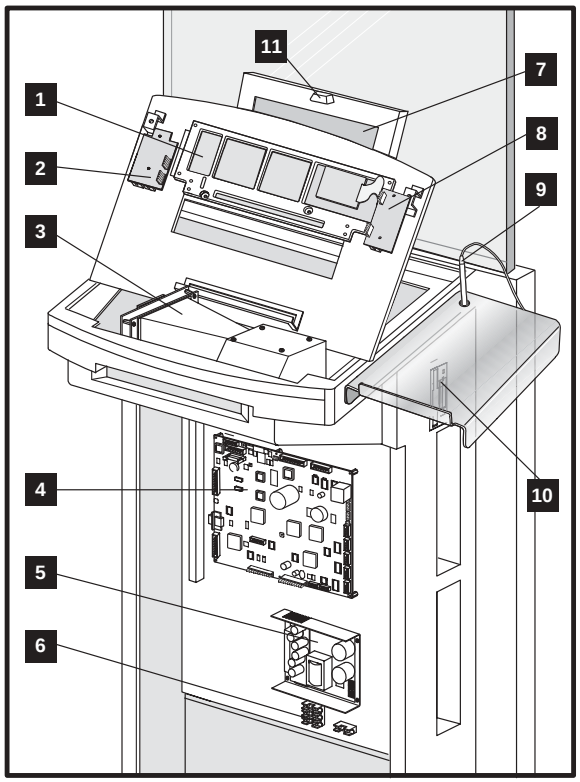


Figure 6-1: Operator Console Components

2.0 Remove and Replace Procedures

Before performing any remove and replace procedure, ensure that all electrical safety precautions are met. Power down the unit, switch OFF the input power circuit breaker, then disengage the voltage source. Perform the applicable lock-out or tag-out procedure at the source junction box before removing any covers. Refer to Section 5 for cover removal procedures.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

2.1 Console Keyboard

This procedure describes removing the keyboard from the Operator Console control panel.

1. Remove the Operator Console Control Panel from the Console as per Chapter 5, Section 5.2.1 Steps 6 through 10. Turn the Control Panel over to access the Keyboard. Refer to Figure 6-2.
2. Disconnect the Keyboard cable from the Operator Microprocessor (TJ29). Note that it will be necessary to remove the front cabinet panel to access the Operator Microprocessor.
3. For units with the optional Bar Code Reader, disconnect the Keyboard cable from the Bar Code Reader Module (keyboard jack). The module is in the Console top shelf structure behind the AutoFilm ID assembly.
4. Remove the ground wire from the Keyboard mount chassis. Remove all mounting hardware, then lift the mounting chassis and keyboard off of the Control Panel.
5. Reverse this procedure to install the replacement keyboard.

Note…BE SURE to reconnect the ground wire before replacing the Control Panel.

6. Apply power to the system. Check the Control Panel Keypads functionality (Alphanumeric, Mammographic View, Function, and Exposure Technique Select) by pressing each key and verifying the key performs as described in Chapter 3 of the Operators Manual.

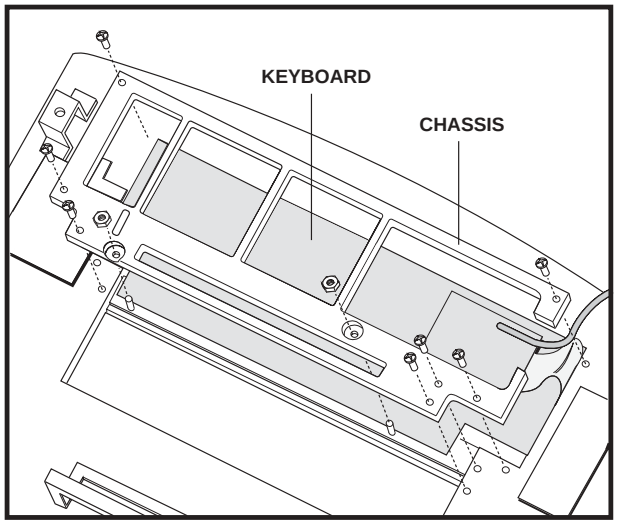


Figure 6-2: Console Keyboard—Removal

2.2 X-ray and Compression Release Switch Board (Right Side)

The system incorporates two x-ray switch boards; one on the left side of the control panel and one on the right side. The x-ray switch board on the right side also contains the Compression Release switch.

1. Remove the Operator Console Control Panel as per Chapter 5, Section 5.2.1. Turn the Control Panel over to access the switch board. Refer to Figure 6-3.
2. Remove the cables from connectors UJ1 (compression release) and UJ2 (X-ray).
3. Remove the hardware that mounts the switch board to the standoffs.
4. Gently pull the switch board straight off the control panel. Use care not to damage the switch leads when removing.
5. Pull the two switches out from the Control Panel, then install the replacement switches.
6. Carefully place the switch board onto the standoffs. Be sure that the switch leads align with the receptacles in the switch sockets, then press down gently to make the connection.
7. Secure the board with the mounting hardware, then replace the control panel.
8. Apply power and check each switch function. Set the unit for a short exposure (25 kV, 3 mAs, Manual Mode, Large Focal Spot), press both X-ray switches and verify proper switch operation.
9. Press the Compression Release Switch and verify the Compression Clutch Brake disengages and the Compression Device moves up.

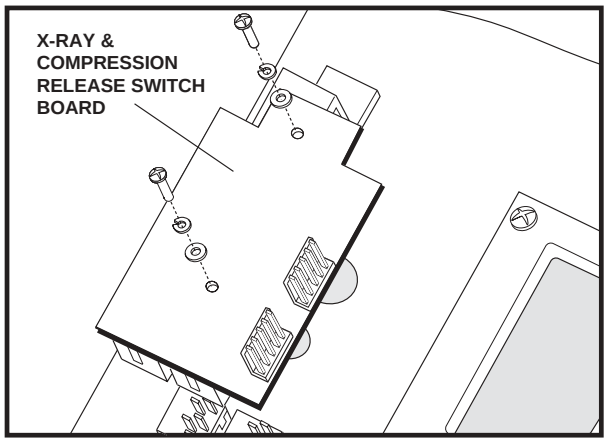


Figure 6-3: X-ray and Compression Release Switch Board—Removal

2.3 X-ray and ON/OFF Switch Board (Left Side)

The system incorporates two x-ray switch boards; one on the left side of the control panel and one on the right side. The x-ray switch board on the left side also contains the power ON and OFF buttons.

1. Remove the Operator Console Control Panel from the Console as per Chapter 5, Section 5.2.1 Steps 6 through 10. Turn the Control Panel over to access the board. Refer to Figure 6-4
2. Remove the cables from connectors VJ1 (X-ray) and VJ2 (ON/OFF).
3. Remove the hardware that mounts the board to the standoffs.
4. Gently pull the board straight off the Control Panel. Use care not to damage the leads when removing.
5. Pull the three buttons out from the Control Panel, then install the replacement buttons.
6. Carefully place the board onto the standoffs. BE SURE that the button leads align with the receptacles in the sockets, then press down gently to make the connection.
7. Secure the board with the mounting hardware, then replace the Control Panel.
8. Check each button function. Press the ON button and verify that the system powers up.
9. Set the unit for a short exposure (25 kV, 3 mAs, Manual Mode, Large Focal Spot), press both X-ray switches and verify proper operation.
10. Press the OFF button and verify that the system shuts down.

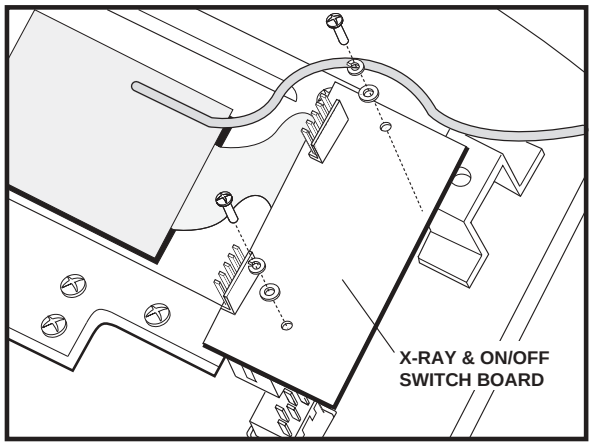


Figure 6-4: X-ray and ON/OFF Switch Board—Removal

2.4 Console Display

The M-IV Console Display mounts to a bracket beneath the control panel which must be removed to access the mounting hardware. For those units with the keyboard LED (Item 11, Figure 6-1) installed, in event of LED failure, the Console Display must be replaced to correct the problem.

1. Remove the Operator Console Control Panel and Front Cabinet Panel as per Chapter 5, Section 5.2.1.
2. Disconnect the Console Display ribbon cable from TJ28 on the Operator Interface Microprocessor (Item 4, Figure 6-1) in the front component compartment.
3. Disconnect the backlight connector from TJ27 on the Operator Interface Microprocessor (Item 4, Figure 6-1) in the front component compartment.
4. Disconnect the Keyboard LED (Item 11, Figure 6-1) cable from P4 (part of the sub-panel cable harness in the front component compartment).
5. Remove the hardware that fastens the Display mount to the console frame (see Figure 6-5). Lift the Display and mount out of the console.
6. Carefully pull the cable(s) up and out of the console. Disconnect the ground wire from the mount.
7. Remove the hardware that fastens the Display to the mount. Install the replacement Display onto the mount, then attach the ground wire.
8. Route the Console Display cable(s) through the slot in the console top shelf. Connect the Console Display ribbon cable to TJ28 on the Operator Interface Microprocessor, then connect the backlight connector to TJ27 on the Operator Interface Microprocessor.
9. Connect the Keyboard LED cable to P4 (part of the sub-panel cable harness in the front component compartment).
10. Align the holes in the Display and mount with the holes in the console frame. Install and tighten the mounting hardware.
11. Apply power to the system and verify that the Display works. Check that the Display presentation is crisp and bright, and that the text and graphics are clear, legible, and not blurred.
12. Replace all covers and panels before releasing the unit to the user.

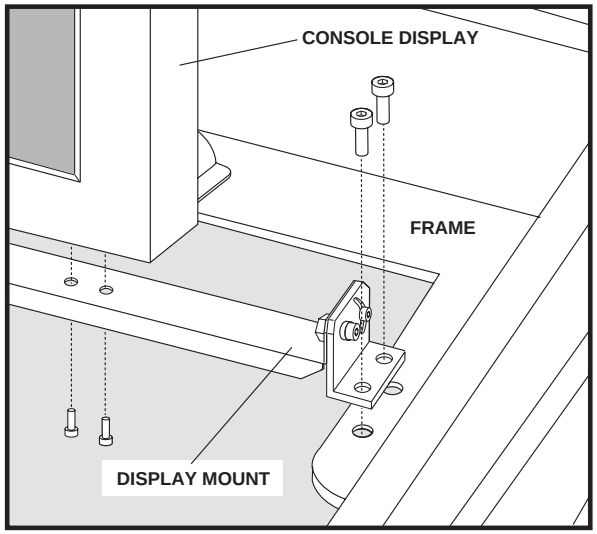


Figure 6-5: Console Display—Removal

2.5 AutoFilm ID Assembly

The AutoFilm ID assembly (Item 2, Figure 6-6) mounts to the base of the Operator Console top shelf. The mounting hardware is accessed by removing the Control Panel.

1. 1.Remove the Operator Console Control Panel and Front Cabinet Panel as per Chapter 5, Section 5.2.1.
2. Remove the Console Display as per Section 6.2.4.
3. Remove the hardware (Item 1, Figure 6-6) that secures the AutoFilm ID Cassette Guide Assembly (Item 8, Figure 6-6) to the Console top shelf.
4. Remove the hardware (Item 3, Figure 6-6) that mounts the plastic bezel (Item 4, Figure 6-6) to the AutoFilm ID Base assembly (Item 9, Figure 6-6). At this time, the two insulated grounding straps (Item 7, Figure 6-6) between the Cassette Guide Assembly and the Base Assembly will be removed.
5. Remove the plastic bezel from the front slot (Item 5, Figure 6-6) in the Console. It may be necessary to work the bezel back-and-forth while pulling the bezel from the Console.
6. Disconnect the AutoFilm ID cables from the connectors on the Operator Microprocessor (TJ8, TJ10). Lift the entire AutoFilm ID assembly from the Console.
7. Reverse this procedure to install the replacement AutoFilm ID assembly.

Note…Before you tighten the mounting hardware, be sure to align the AutoFilm ID assembly with the plastic bezel to form a direct path for cassette insertion.

8. Apply power to the system. Set the unit for a short Manual mode exposure (25 kV, 3 mAs, Manual Mode, Large Focal Spot).
9. Install a loaded Bucky in the cassette slot (Item 6, Figure 6-6) and make the exposure. Remove the cassette, then insert it into the AutoFilm ID to flash the data onto the film.
10. Develop the film and check the “flashed” data for accuracy. If necessary, adjust AutoFilm ID Contrast, the AutoFilm ID Offset, and the flash duration for each film type.

Legend for Figure 6-6

1. Hardware (secures AutoFilm ID to console top shelf)
2. AutoFilm ID
3. Hardware (mounts plastic bezel to AutoFilm ID)
4. Plastic Bezel
5. Console Front Slot
6. Cassette Slot
7. Insulated Ground Strap
8. AutoFilm ID Cassette Guide Assembly
9. AutoFilm ID Base Assembly

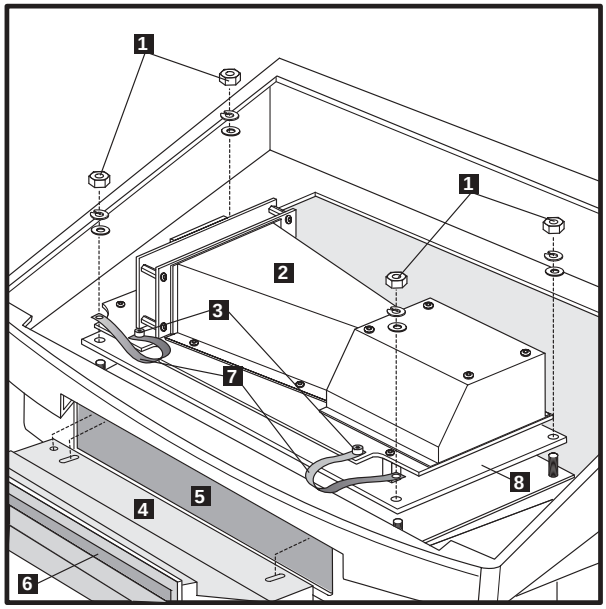


Figure 6-6: AutoFilm ID Assembly—Removal

2.6 Floppy Disk Drive

The floppy disk drive mounts to a bracket assembly on the inside rear bulkhead of the Operator Console. The mounting hardware is accessed by removing the Control Panel.

1. Remove the Operator Console Control Panel from the Console as per Chapter 5, Section 5.2.1 Steps 6 through 10.
2. Check the orientation of the ribbon cable, then remove the ribbon cable (Item 1, Figure 6-7) and the power cable from the connector (Item 2, Figure 6-7) on the rear of the floppy disk drive (Item 7, Figure 6-7).
3. Remove the hardware (Item 3, Figure 6-7) that secures the floppy disk drive and drive mount (Item 5, Figure 6-7) to the Console frame.
4. Pull the floppy disk drive assembly inward until the drive faceplate clears the Console frame, then lift the assembly out of the Console.
5. Remove the hardware (Item 4, Figure 6-7) that secures the floppy disk drive to the mount.
6. Secure the replacement floppy disk drive onto the mount, then slide the disk drive into the drive slot (Item 6, Figure 6-7) in the Console.
7. Adjust the floppy disk drive position so that the faceplate is flush with the Console frame, then tighten the mounting hardware.
8. Replace the ribbon data cable and the power cable.
9. Replace the Operator Console Control Panel by reversing the procedures in Section 5.2.1 Steps 6 through 10.
10. Apply power and verify that the floppy disk drive indicator lamp illuminates for approximately 3 seconds during the boot-up process, indicating drive recognition.

Legend for Figure 6-7

1. Ribbon Data Cable
2. Power Cable Connector
3. Hardware (secures floppy disk drive and drive mount to console frame)
4. Hardware (secures floppy disk drive to drive mount)
5. Drive Mount
6. Drive Slot
7. Floppy Disk Drive

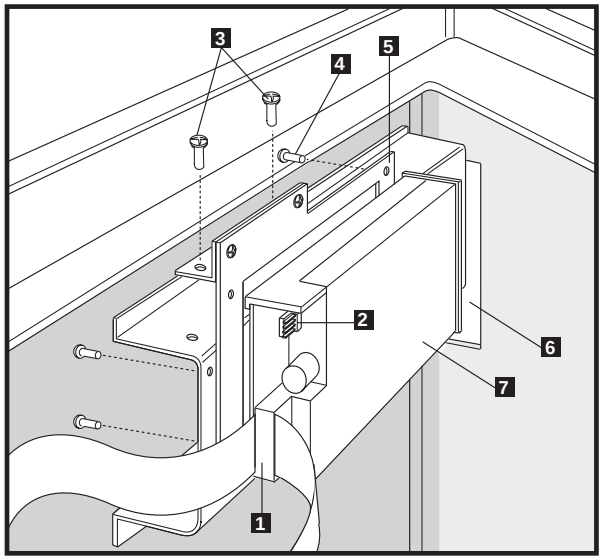


Figure 6-7: Floppy Disk Drive—Removal

2.7 Operator Interface Microprocessor Board

The Operator Microprocessor Board mounts to standoffs in the front component compartment of the Operator Console. Access the circuit board by removing the front cabinet panel.

CAUTION!

The Operator Interface Microprocessor contains data storage components that are sensitive to electromagnetic fields. NEVER place items with a magnetic charge, or items that produce an electromagnetic field, on or near the Operator Interface Microprocessor.

1. Remove the Front Cabinet Panel from the Console as per Chapter 5, Section 5.2.1 Steps 1 through 5.
2. Remove all cables and cords from their respective connectors on the microprocessor board. Note all cable and cord locations.
3. Remove the hardware that secures the Operator Interface Microprocessor to the console frame (standoffs). Lift the board out of the console. Refer to Figure 6-8.
4. Install the replacement Operator Interface Microprocessor by reversing this procedure.
5. Apply power to the system. Verify that the floppy disk drive indicator lamp illuminates for approximately three seconds during the boot-up process, indicating drive recognition. Check the Control Panel Keypads functionality (Alphanumeric, Mammographic View, Function, and Exposure Technique Select) by pressing each key and verifying the key performs as described in the Operators Manual.
6. Verify that the display works. Check that the display presentation is crisp and bright, and that the text and graphics are clear, legible, and not blurred.
7. Set unit for a short exposure (25 kV, 3 mAs, Manual Mode, Large Focal Spot), press both X-ray switches and verify proper switch operation.
8. Remove the cassette from the Bucky and then insert it in the AutoFilm ID to flash the data onto the film. Develop the film and verify the “flashed” data for accuracy.

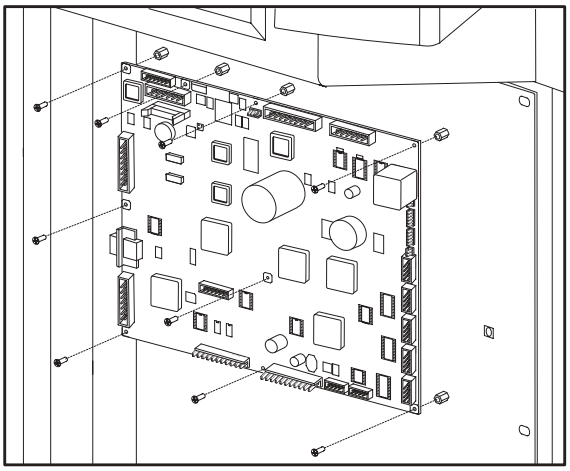


Figure 6-8: Operator Microprocessor Board—Removal

2.8 Low Voltage Power Supply

The Low Voltage Power Supply mounts to the Console chassis in the front component compartment. Refer to Figure 6-9. Access the power supply by removing the front cabinet panel.

1. Remove the Front Cabinet Panel from the Console as per Chapter 5, Section 5.2.1 Steps 1 through 5.
2. Remove the input power wires from the terminal block (TB1). The terminal block (TB1) configuration is as follows:

   Pin 1 : Ground
   Pin 2 : Neutral
   Pin 3 : Line

3. Remove the large connector and the 5 volt input wires from the terminal block (TB2).
4. Remove the hardware that secures the Low Voltage Power Supply to the Console frame. Note that one of the mounting screws secures an earth ground wire.
5. Reverse these steps to install the replacement Low Voltage Power Supply. BE SURE to fasten the earth ground wire with one of the mounting screws during installation.
6. Connect a DMM to the Operator Interface Board at TP21 (GND) and TP4 (+). Adjust V1 on the Low Voltage Power Supply (located in the upper left corner of the power supply) for +5.15 VDC.
7. Perform the System Level Functional Check as per Chapter 4, Section 4.5.3.

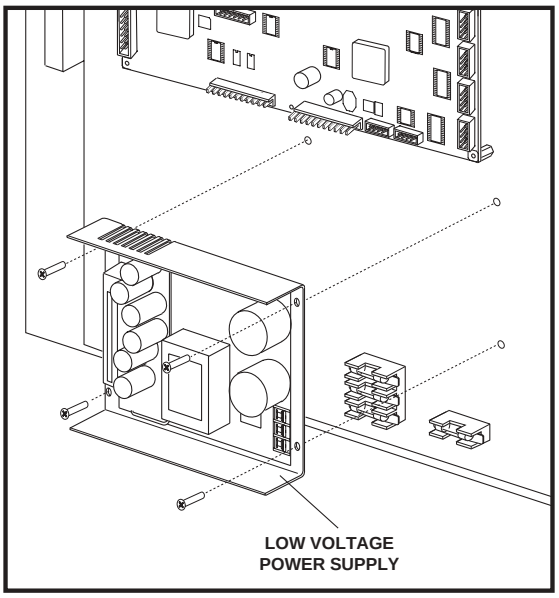


Figure 6-9: Low Voltage Power Supply—Removal

3.0 Test Points

Use the following test point table as a guide for troubleshooting the circuit board in the M-IV Operator Console.

3.1 Operator Interface Microprocessor

Table 6-1 shows the test points and their voltages/signals on the Operator Interface Microprocessor. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 6-1: Test Point Voltage Matrix

TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	R/W#	TP6
TP2	VEE	TP6
TP3	BUTTON	TP6
TP4	VCC	TP6
TP5	+12V	TP6
TP6	GND	N/A
TP7	BACKLIGHT	TP6
TP8	CASSETTE	TP6
TP9	EL DRIVE	TP6
TP10	GND	N/A
TP11	KYBD	TP6
TP12	BAR TXD	TP6
TP13	BAR RXD	TP6
TP14	RXD0	TP6
TP15	RXD1	TP6
TP16	TXD1	TP6
TP17	TXD0	TP6
TP18	COMP REL	TP6
TP19	XRAY SW	TP6
TP20	GND	N/A
TP21	GND	N/A
TP22	GND	N/A
TP23	LCD VEE	TP6

Chapter 7: Gantry Maintenance

1.0 Parts Identification

Figures 7-1 and 7-2 show the locations of the serviceable Gantry components. Figure 7-1 shows the locations of the gantry circuit boards. Figure 7-2 shows the locations of the gantry mechanical assemblies.

Legend for Figure 7-1

1. Rotation Display Board (2)
2. High Voltage Transformer (Part of High Voltage Generator Assy)
3. High Voltage Multiplier Board (Part of High Voltage Generator Assy)
4. High Voltage Inverter Board (Part of High Voltage Generator Assy)
5. High Voltage Control Board (Part of High Voltage Generator Assy)
6. Generator Microprocessor Board
7. Filament Control Board
8. Rotor Control Board
9. Mains Power Board
10. C-arm Microprocessor Board
11. Host Microprocessor Board
12. Motor/Lamp Control Board
13. Fuse Panel (2)
14. VTA Motor Driver Board
15. Power Distribution Board
16. Isolation Transformer
17. Power Supply Interconnect Board
18. ±15 V Power Supply Board (StereoLoc II only)
19. Pivot Tube

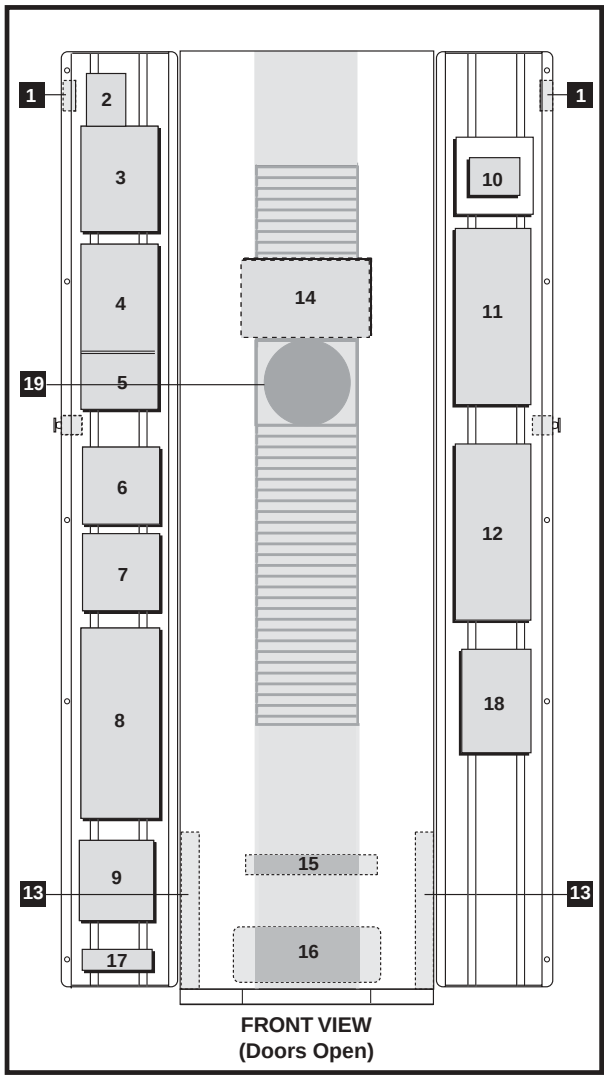


Figure 7-1: Gantry Circuit Boards

Legend for Figure 7-2

1. C-arm Rotation Drive Motor and Gearbox Assembly
2. C-arm Vertical Drive Motor and Gearbox Assembly
3. C-arm Rotation Potentiometer
4. C-arm UP/DOWN Limit Switches
5. C-arm Rotation Limit Switch
6. Lead Screw

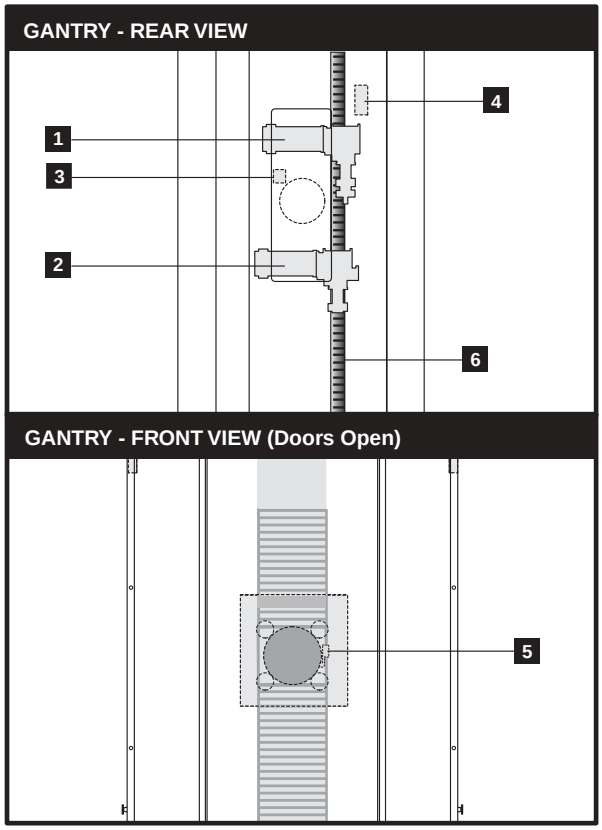


Figure 7-2: Gantry Mechanical Components

2.0 Gantry Door Components—Remove and Replace

Before performing any remove and replace procedure, ensure that all electrical safety precautions are met. Power down the unit, set the input power circuit breaker to OFF, then disengage the voltage source. Perform the applicable lock-out or tag-out procedure at the source junction box before removing any covers.

2.1 H.V. Generator Assembly

Always remove power before performing any removal or replacement procedure. The High Voltage Generator Assembly panel consists of four circuit boards:

- the High Voltage Transformer
- the High Voltage Multiplier
- the High Voltage Inverter
- the High Voltage Control

Note…In order to retain Compliance, the High Voltage Generator Assembly must be removed as a single unit.

WARNING!

To reduce the risk of hazardous electrical shock, DO NOT attempt service until LED D14 is unlit and at least 5 minutes have elapsed after turning off the equipment.

1. Access the High Voltage Generator Assembly panel by opening the left side Gantry door as per Chapter 5, Section 2.2 Step 1.
2. Disconnect high voltage cable from high voltage test well near the top. Refer to Figure 7-3.
3. Remove ground wire #1.
4. Loosen the two upper screws holding the assembly to the gantry.
5. Cut all cable ties that secure the wiring harness.
6. Remove the bottom screw on the safety shield and loosen the top one enabling you to move the shield out of the way.

WARNING!

LED D14 must be OFF and five minutes must have elapsed since removing power to the equipment before continuing.

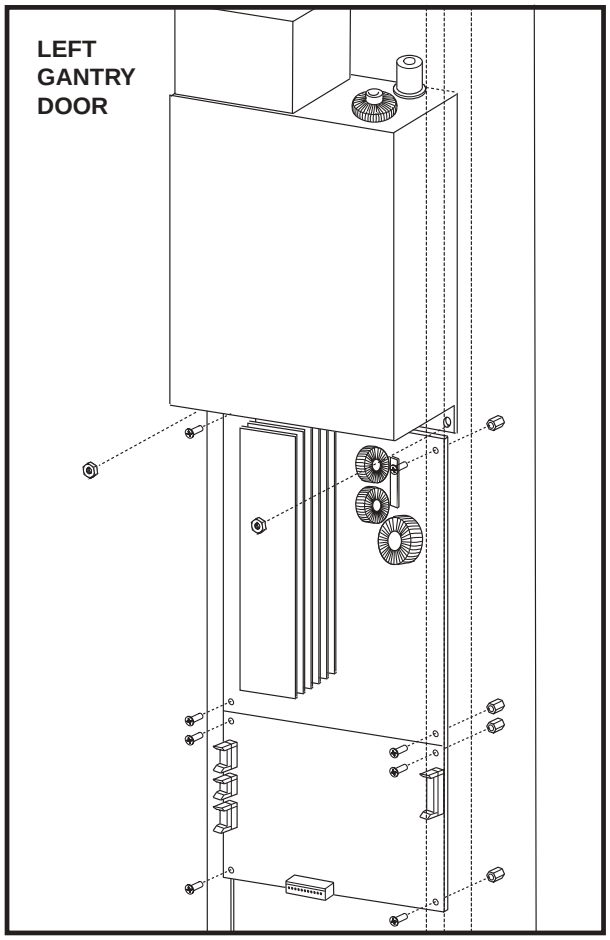


Figure 7-3: Removal—High Voltage Generator Assembly

7. Disconnect PJ1.
8. Unscrew the EMO switch assembly and move wires out of the way.
9. Remove the middle and bottom screws holding the assembly to the gantry.
10. Disconnect the connectors NJ1, NJ4 and NJ5 from the HV control board.
11. With one hand on the multiplier board and one hand under the HV control board frame, lift up the assembly taking care to clear the bottom studs, removing the assembly from the gantry.
12. Once it is clear, slide it down to clear the upper studs removing the entire assembly.
13. Reverse procedures to replace the H.V. Generator Assembly.
14. Perform the following procedures before returning unit to service:
    - Chapter 3, Section 4.1, Line Regulation Check
    - Chapter 3, Section 4.4, Tube Current (mA) Adjustment
    - Chapter 3, Section 4.5, Tube Voltage Potential (kV) Adjustment
    - Chapter 3, Section 5.0, Automatic Exposure Control Calibration (all)
    - Chapter 4, Section 2.0, X-ray System Performance (all)
    - Chapter 4, Section 4.2, M-IV Bucky Device (HTC Grid) Performance Check
    - Chapter 4, Section 4.3, Maximum mAs in Auto-Time Mode Performance Check
    - Chapter 7, Section 5.1, H. V. Control Board Over-Current / Over-Voltage Adjustment

2.2 Generator Microprocessor Board

Always remove power before performing any removal or replacement procedure. Access the Generator Microprocessor Board by opening the left side Gantry door.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Disconnect the harness connectors from AGJ2, AGJ7, and AGJ8 on the board.
2. Disconnect the 40 pin ribbon cable from AGJ3 on the board.
3. Disconnect the 20 pin ribbon cable from AGJ1 on the board.
4. Disconnect the RJ45 jack from AGJ5 on the board.
5. Disconnect 40 pin ribbon cable from AGJ4.
6. Lift the Generator MPU Board off of the mounting standoffs.
7. Reverse procedures to replace the Generator Microprocessor Board.
8. Perform the following procedures before returning unit to service:
    - Chapter 3, Section 4.4, Tube Current (mA) Adjustment
    - Chapter 3, Section 4.5, Tube Voltage Potential (kV) Adjustment
    - Chapter 3, Section 5.0, Automatic Exposure Control Calibration (all)
    - Chapter 4, Section 2.0, X-ray System Performance (all)
    - Chapter 4, Section 4.1, M-IV Bucky Device (Linear) Performance Check (if applicable)
    - Chapter 4, Section 4.2, M-IV Bucky Device (HTC Grid) Performance Check (if applicable)

2.3 Filament Control Board

Always remove power before performing any removal or replacement procedure. Access the Filament Control Board by opening the left side Gantry door.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Disconnect the harness connectors from AHJ1, AHJ2 and AHJ3 on the board.
2. Disconnect the 40 pin ribbon cable from AHJ4 on the board.
3. Lift the Filament Control Board off of the mounting standoffs.
4. Reverse procedures to replace the Filament Control Board.
5. Perform the following procedures before returning unit to service:
   - Chapter 3, Section 4.3, Tube Bias Adjustment
   - Chapter 3, Section 4.4, Tube Current (mA) Adjustment
   - Chapter 3, Section 5.0, Automatic Exposure Control Calibration (all)
   - Chapter 4, Section 2.0, X-ray System Performance (all)
   - Chapter 4, Section 4.1, M-IV Bucky Device (Linear) Performance Check (if applicable)
   - Chapter 4, Section 4.2, M-IV Bucky Device (HTC Grid) Performance Check (if applicable)
   - Chapter 7, Section 5.2, Filament Control Board Over-Current / Over-Voltage Adjustment

2.4 Rotor Control Board

WARNING!

To reduce the risk of hazardous electrical shock, DO NOT attempt service until 5 minutes have elapsed after turning off the equipment.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

Always remove power before performing any removal or replacement procedure. Access the Rotor Control Board by opening the left side Gantry door.

1. Disconnect the harness connectors from MJ1, MJ2, and MJ3 on the board.
2. Disconnect the 20 pin ribbon cable from MJ4 on the board.
3. Disconnect E1 and E2 quick disconnects.
4. Lift the Rotor Control Board off of the mounting standoffs.
5. Reverse procedures to replace the Rotor Control Board.
6. Perform the following procedures before returning unit to service:
   - Chapter 4, Section 4.4, System Level Functional Check

2.5 Mains Power Board

Always remove power before performing any removal or replacement procedure.

WARNING!

Circuit breaker must be OFF before proceeding.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

Access the Mains Power Board by opening the left side Gantry door.

1. Disconnect the harness connectors from ABJ8 and ABJ6 at the top of the board.
2. Disconnect the harness connectors from ABJ1, ABJ2, ABJ5, and ABJ7 at the left side of the board.
3. Disconnect the harness connectors from ABJ3, ABJ4 and ABJ10 at the right side of the board.
4. Lift the Mains Power Board off of the mounting standoffs.
5. Reverse procedures to replace the Mains Power Board.
6. Perform the following procedures before returning unit to service:
   - Turn power ON. Check for abnormal odors or any other indication of an electrical malfunction.
   - Chapter 3, Section 2.0, Functional Checks—Mechanical
   - Chapter 4, Section 4.4, System Level Functional Check

2.6 C-arm Microprocessor Board

Always remove power before performing any removal or replacement procedure. Access the C-arm Microprocessor Board by opening the right side Gantry door.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Disconnect the harness connectors from AEJ3 and AEJ4 on the board.
2. Disconnect the RJ45 jack from AEJ5 on the board.
3. Lift the C-arm Microprocessor Board off of the mounting standoffs.
4. Reverse procedures to replace the C-arm Microprocessor Board.
5. Chapter 8, Section 6.5, Setting—Force Load Cell

2.7 Host Microprocessor Board

Always remove power before performing any removal or replacement procedure. Access the Host Microprocessor Board by opening the right side Gantry door.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Disconnect the harness connectors from KJ1, KJ2, KJ3, KJ7, KJ8, KJ9, and KJ12 on the board.
2. Disconnect the RJ45 jacks from KJ18, KJ19, KJ20, KJ21, KJ22, KJ23, KJ24, and KJ25 on the board.
3. Lift the Host Microprocessor Board off of the mounting standoffs.
4. Reverse procedures to replace the Host Microprocessor Board.
5. Perform the following procedures before returning unit to service:
   - Chapter 3, Section 4.0, Exposure System Calibration (all)
   - Chapter 3, Section 5.0, Automatic Exposure Control Calibration (all)
   - Chapter 3, Section 7.0, Final Set Up Checks
   - Chapter 4, Section 2.0, X-ray System Performance (all)
   - Chapter 4, Section 3.0, X-ray and Light Field Compliance (all)
   - Chapter 4, Section 4.0, System Performance (all)
   - Chapter 4, Section 5.0, X-ray Shielding Compliance (all)
   - Chapter 7, Section 5.0, Tests, Adjustments, and Calibrations (all)
   - Chapter 8, Section 6.0, Tests, Adjustments, and Calibrations (all)

2.8 Motor/Lamp Control Board

Always remove power before performing any removal or replacement procedure. Access the Motor / Lamp Control Board by opening the right side Gantry door.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Disconnect the harness connectors from CJ7, CJ8, CJ10, CJ11, CJ14, CJ15, CJ16, CJ17, CJ20, CJ21, CJ22, CJ23, CJ24, CJ25, CJ26, CJ27 and CJ29 on the board.
2. For units with StereoLoc II, disconnect CJ12.
3. Disconnect the RJ45 jacks from CJ1, CJ2, CJ3, and CJ5 on the board.
4. Lift the Motor / Lamp Control Board off of the mounting standoffs.
5. Reverse procedures to replace the Motor/ Lamp Control Board.
6. Perform the following procedures before returning unit to service:
   - Chapter 3, Section 2.0, Functional Checks—Mechanical (all)
   - Chapter 3, Section 7.3, C-arm Rotation Speed Check
   - Chapter 7, Section 5.4, C-Arm Switch Interlocks—Verification
   - Chapter 4, Section 4.4, System Level Functional Check

2.9 Rotation Display Boards

Always remove power before performing any removal or replacement procedure. There are two Rotation Display Boards.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

2.9.1 Right Rotation Display Board

The right rotation display board is accessed by opening the right side Gantry door. Remove and replace the board as follows:

1. Disconnect the harness from the rear of the board.
2. Disconnect the RJ45 jack from the rear of the board.
3. Remove the mounting hardware (4 hex nuts) that secure the board to the chassis, then lift the Rotation Display Board out of the Gantry door.
4. Reverse procedures to replace the Rotation Display Boards.
5. Perform the following procedures before returning unit to service:
   - Chapter 4, Section 4.4, System Level Functional Check

2.9.2 Left Rotation Display Board

The High Voltage Generator Assembly must be removed to access the left rotation display board. The high voltage generator assembly is accessed by opening the left side Gantry door. Remove and replace the left rotation display board as follows:

1. Remove the High Voltage Generator Assembly as per Section 2.1 of this chapter.
2. Disconnect the harness from the rear of the board.
3. Remove the mounting hardware (4 hex nuts) that secure the board to the chassis, then lift the Rotation Display Board out of the Gantry door.
4. Reverse procedures to replace the Rotation Display Boards.
5. Perform the following procedures before returning unit to service:
   - Chapter 4, Section 4.4, System Level Functional Check

3.0 Gantry Frame Components—Remove and Replace

Before performing any remove and replace procedure, ensure that all electrical safety precautions are met. Power down the unit, switch OFF the input power circuit breaker, then disengage the voltage source. Perform the applicable lock-out/tag-out procedure at the source junction box before removing any covers.

WARNING!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

3.1 VTA Motor Driver Board

WARNING!

To reduce the risk of hazardous electrical shock, DO NOT attempt service until 5 minutes have elapsed after turning off the equipment.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

The procedures for removing and replacing the VTA Motor Driver Board in an M-IV configured unit are described in Section 3.1.1. The procedures for removing and replacing the VTA Motor Driver Board in a StereoLoc II configured M-IV unit are described in Section 3.1.2.

3.1.1 M-IV Configuration VTA Motor Driver Board

Always remove power before performing any removal or replacement procedure.

1. Remove the VTA frame as per Chapter 5, Section 2.2, Steps 1 through 7.
2. Disconnect harness connectors WJ1, WJ3, WJ5, WJ6, WJ7, WJ12, WJ13, WJ14 and WJ16 from the VTA Motor Driver Board.
3. Remove 7 screws and associated hardware securing board to the VTA.
4. Remove board.
5. Reverse the above procedures to install new VTA Motor Driver Board.
6. Perform the following procedures before returning unit to service:
   - Section 2.1, Functional Checks—Compression System
   - Section 2.2, Functional Checks—C-arm Movement System
   - Section 5.4.1, Switch Interlock (Power Up) Check

3.1.2 StereoLoc II Configuration VTA Motor Driver Board

Always remove power before performing any removal or replacement procedure.

1. Open the left and right front Gantry Covers as per Chapter 5, Section 2.2, Steps 2 through 4.
2. Disconnect harness connectors WJ1, WJ3, WJ5, WJ6, WJ7, WJ12, WJ13, WJ14 and WJ16 from the VTA Motor Driver Board.
3. Locate 3 locking standoffs at top of board, release standoff locks and remove top of board from standoffs.
4. Lift board slightly up and away from VTA and remove board through right side of Gantry frame.
5. Reverse the above procedures to install new VTA Motor Driver Board.
6. Perform the following procedures before returning unit to service:
   - Section 2.1, Functional Checks—Compression System
   - Section 2.2, Functional Checks—C-arm Movement System
   - Section 5.4.1, Switch Interlock (Power Up) Check

3.2 C-arm Rotation Drive Motor and Gearbox Assembly

1. Remove the upper rear Gantry panel as per Chapter 5, Section 2.2 Steps 8 and 9.
2. Position C-arm so the C-arm Rotation Drive Motor and Gearbox Assembly (Item 1, Figure 7-2) is accessible through the Gantry upper rear access hole.
3. Turn power OFF.
4. From rear of unit, disconnect the motor power cable from the wiring harness. Cut all cable ties securing the harness to the motor and gearbox assembly.
5. On the drive coupling (Item 1, Figure 7-4), loosen the upper coupling screw (Item 2, Figure 7-4).
6. Remove the four bolts (Item 3, Figure 7-4) that mount the motor and gearbox assembly to the VTA.
7. Lift assembly shaft (Item 4, Figure 7-4) out of drive coupling and remove motor and gear assembly through Gantry upper rear access hole.
8. Reverse this procedure to reinstall the C-arm Rotation Drive Motor and Gearbox Assembly.
9. Turn power ON. Verify the C-arm Rotation Drive Motor and Gearbox Assembly is working properly before releasing the unit to the user (refer to Chapter 3, Section 2.2 Steps 3 and 4).

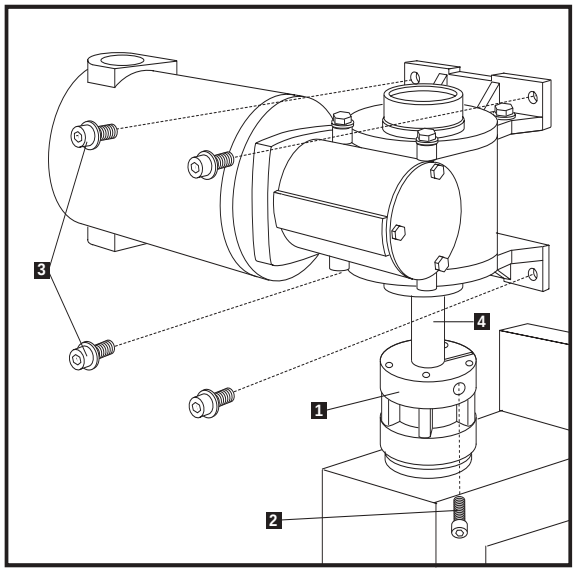


Figure 7-4: C-arm Rotation Drive Motor and Gearbox Assembly—Removal

3.3 C-arm Vertical Drive Motor and Gearbox Assembly

1. Remove the Gantry left front cover as per Chapter 5, Section 2.2, Steps 1 through 3.
2. Remove the upper rear Gantry panel as per Chapter 5, Section 2.2 Steps 8 and 9.
3. Position C-arm so the C-arm Vertical Drive Motor and Gearbox Assembly (Item 1, Figure 7-2) is accessible through the Gantry upper rear access hole.
4. Turn power OFF.
5. From rear of unit, disconnect the motor power cable from the wiring harness. Cut all cable ties securing the harness to the motor and gearbox assembly.
6. From front left side of unit, at bottom of C-arm drive pulley coupler (Item 1, Figure 7-5), remove 2 hex head bolts.
7. Insert lever (or pry bar) between the C-arm drive pulley coupler and the C-arm drive pulley (Item 2, Figure 7-5). Using lever, push down on the coupler until the machine lock is broken and the coupler and drive pulley can be removed from the assembly shaft (Item 3, Figure 7-5).
8. Remove coupler, drive pulley and key (Item 4, Figure 7-5), take care not to drop key. Note pulley position and key-way orientation. As pulley is removed, belt may fall to bottom of unit (around lead screw {Item 6, Figure 7-2}). Set coupler, drive pulley, and key aside.
9. From rear of unit, remove the four bolts (Item 5, Figure 7-5) that mount the motor and gearbox assembly to the Vertical Travel Assembly (VTA).
10. Reverse this procedure to reinstall the C-arm Rotation Drive Motor and Gearbox Assembly. Ensure the following:
    - Belt is positioned around the C-arm drive pulley and the lead screw nut pulley prior to tightening the 2 C-arm drive pulley hex head bolts.
    - Pulley is positioned and key way is aligned with drive shaft as noted in Step 7 above.
    - Key is installed.
11. Verify that the C-arm Vertical Drive is working properly before releasing the unit to the user (refer to Chapter 3, Section 2.2 Steps 1 and 2).

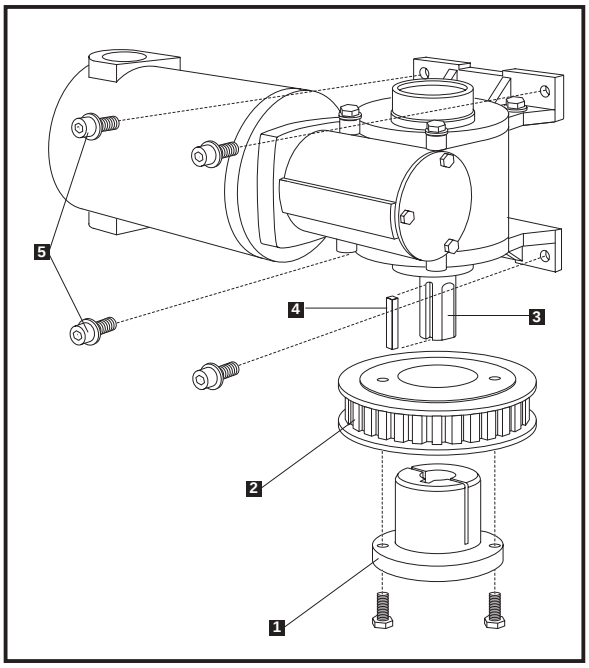


Figure 7-5: C-arm Vertical Drive Motor—Removal

3.4 C-arm Rotation Potentiometer

1. Access the C-arm Rotation Potentiometer by removing the upper rear Gantry cover as per Chapter 5, Section 2.2, Steps 5 and 6.
2. Raise C-arm so the C-arm Rotation Potentiometer (Item 2, Figure 7-6) is positioned as shown in Upper Rear Access Hole (Item 1, Figure 7-6) at the rear of the unit.
3. Remove cable ties securing wires to mounting bracket.
4. Note position of wires on potentiometer (Pins 1, 2 and 3 on Figure 7-6), de-solder wires.
5. Remove 2 screws securing rotation potentiometer mounting bracket (Item E, Figure 7-6) to Vertical Travel Assembly (VTA). Remove bracket with potentiometer attached.
6. Note the alignment of potentiometer to mounting bracket.
7. Loosen the screw (A) on the end of the potentiometer shaft (B). Remove the sprocket assembly (C) (refer to Figure 7-6).
8. Remove the hex nut (D) that secures the potentiometer to the mounting bracket. Slide the potentiometer out of the bracket.
9. Reverse steps 3 through 8 to install the replacement sensor.
10. Perform the Section 5.3, Rotation Angle Calibration procedures.

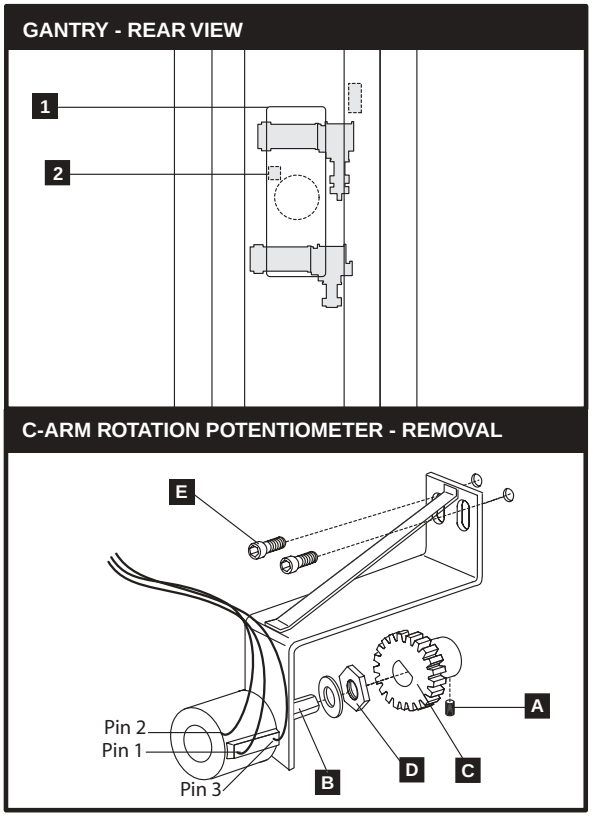


Figure 7-6: C-arm Rotation Potentiometer—Removal

3.5 Gantry Components Preventive Maintenance

The following sections provide preventive maintenance procedures for the following Gantry components:

- C-arm Rotation Gear Assembly (part of Item 1, Figure 7-2)
- VTA Assembly Lead Screw (Item 6, Figure 7-2)

3.5.1 C-arm Rotation Gear Assembly Inspection and Lubrication

The recommended periodicity for this procedure is annually or as required (any time the upper rear cover is off the unit for service, the rotation gear assembly should be inspected).

1. Turn power OFF.
2. Remove the Gantry Upper Rear Access Panel as per Chapter 5, Section 2.2, Steps 8 and 9.
3. Locate and inspect the gear assembly for loose hardware.
4. Check harnesses for proper dress and clearances.
5. Clean and lightly lubricate C-arm rotation gear assembly (if required) using approximately 1 tablespoon of synthetic type lubricant (LORAD PN 2-580-0207). Apply lubricant with brush ensuring gear teeth and worm gear are evenly coated.
6. Turn power ON.
7. Rotate C-arm through full operational travel. Remove any excess lubrication.
8. Replace Upper Rear Access Panel.

3.5.2 VTA Lead Screw Inspection and Lubrication

The recommended periodicity for this procedure is annually or as required (any time the left front cover is off the unit for service, the VTA lead screw should be inspected).

1. Turn power OFF.
2. Remove the Gantry Left Front Cover as per Chapter 5, Section 2.2, Steps 1 through 4 (do not remove right front cover).
3. Locate and inspect the VTA lead screw for loose hardware.
4. Check harnesses for proper dress and clearances.
5. Clean and lightly lubricate the VTA lead screw (if required) using approximately 2 tablespoons of synthetic type lubricant (LORAD PN 2-580-0207). Evenly coat all metal surfaces.
6. Turn power ON.
7. Raise C-arm to top of vertical travel. Lower C-arm to bottom of vertical travel. Remove any excess lubrication.
8. Replace Gantry Left Front Cover.

4.0 Test Points

Use the following test point tables as a guide for troubleshooting the circuit boards in the M-IV Gantry.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

4.1 High Voltage Inverter Board and High Voltage Multiplier Board

Table 7-1 shows the test points and their voltages or signals on the High Voltage Inverter Board. Some of these test points refer to voltages or signals on the High Voltage Multiplier Board, which is not accessible. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-1: High Voltage Inverter Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	LIS. CLAMP	TP7
TP2	15V RETURN	---
TP3	BRIDGE	TP7
TP4	PRIMARY A	TP7
TP5	INV DRV D	TP7
TP6	CLAMP V	TP2
TP7	320V RETURN	---
TP8	INV DRV C	TP7
TP9	INV DRV B	TP7
TP10	OVER 1	TP2
TP11	INV DRV A	TP7
TP12	PRIMARY B	TP7

4.2 High Voltage Control Board

Table 7-2 shows the test points and their voltages or signals on the High Voltage Control Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-2: High Voltage Control Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	O.V. 0	TP24	**TP2**	INV O.C. SET*	TP24
TP3	KV SEN	TP24	**TP4**	MA SEN	TP24
TP5	INV 1	TP24	**TP6**	Vfb	TP24
TP7	KV ERR	TP24	**TP8**	SM SET*	TP24
TP9	LG SET*	TP24	**TP10**	B DRV	TP24
TP11	TUBE 1	TP24	**TP12**	A DRV	TP24
TP13	SHUT DN	TP24	**TP14**	-20V	TP24
TP15	+20V	TP24	**TP16**	CLAMP	TP24
TP17	DGND	N/A	**TP18**	KV PROG	TP24
TP19	R +15V	TP24	**TP20**	+5V	TP17
TP21	+10V	TP17	**TP22**	-15V	TP24
TP23	+15V	TP24	**TP24**	AGND	---
TP26	mA fb	TP24	**TP27**	HV FAULT INLK	TP17
TP28	VREF	TP24	**TP29**	+12.5V	TP24
TP30	BACKUP	TP17			

*See Table 7-3

4.3 Filament Control Board

Tables 7-3 and 7-4 show the test points and their voltages or signals on the Filament Control Board. Use TP7 as ground when making Filament Board measurements, and TP24 when making H.V. Control Board measurements. Refer to Table 7-3 when test point voltages depend upon the type of tube present.

Table 7-3: Tubehead Variables

FILAMENT CTRL. BD.	FUNCTION OVER-CURRENT	SMALL FIL OVER-CURRENT	LARGE FIL OVER-CURRENT	FILAMENT OV
	TEST POINT	TP17	TP16	TP8
	ADJUST	R45	R44	R20
	TOSHIBA	4.3 VDC	4.3 VDC	10.0 VDC
	VARIAN M-113 (O)	6.0 VDC	6.0 VDC	12.5 VDC
	VARIAN M-113-1 (A)	6.0 VDC	6.0 VDC	12.5 VDC
	VARIAN M-113-1A (A)	4.8 VDC	4.8 VDC	11.0 VDC
	VARIAN M-113-R (O)	4.8 VDC	4.8 VDC	11.0 VDC
H.V. CTRL BD.	**FUNCTION**	**TEST POINT**	**ADJUST**	**VOLTAGE**
	SMALL O/C	TP8 (+)	R33	1.8 VDC
	LARGE O/C	TP9 (+)	R32	6.0 VDC
	INVERTER	TP2 (+)	R3	8.5 VDC
	OVER VOLTAGE	TP1 (+)	R6	11.0 VDC

*The Varian tubes are identified by their labels on the cathode end of the tube housing. Varian types 0 and 1 are labeled M113; Varian type -1A is labeled M113-1A.

Table 7-4: Filament Control Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	FIL PROGRAM	TP7	**TP2**	+10V	TP3
TP3	DGND	---	**TP4**	+5V	TP3
TP5	+20V	TP7	**TP6**	-20V	TP7
TP7	AGND	---	**TP8**	O.V. SET*	TP7
TP9	ERR OUT	TP7	**TP10**	INV 1	TP7
TP11	GRID PRGM	TP7	**TP12**	GRID FB	TP7
TP13	+15V	TP7	**TP14**	O.C. FAULT	TP7
TP15	O.V. FAULT	TP7	**TP16**	LG O.C. SET*	TP7
TP17	SM O.C. SET*	TP7	**TP18**	GRID MONITOR	TP7
TP19	PGND	---	**TP20**	-15V	TP7
TP21	FB	TP7	**TP22**	GATE DRV	TP7
TP23	+25V	TP19	**TP24**	FIL 1 MON	TP7
TP25	FIL 1	TP7	**TP26**	FIL 1 ADJ	TP7
TP27	GRID U.V.	TP7	**TP28**	GRID O.V.	TP7
TP29	FIL V	TP7	**TP30**	RAMP	TP7
TP31	FIL 1 MON	TP7	**TP32**	12.5	TP7
TP33	V REF (5.1)	TP7	**TP33**	GRID V	TP7

*See Table 7-3

4.4 Generator Microprocessor Board

Table 7-5 shows the test points and their voltages or signals on the Generator Microprocessor Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-5: Generator Microprocessor Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	DGND	---
TP3	+5V	TP1
AGJ2-1	10V	TP1

4.5 Rotor Control Board

Table 7-6 shows the test points and their voltages or signals on the Rotor Control Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-6: Rotor Control Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	GATE DRV C	TP7	**TP2**	GATE DRV A	TP7
TP3	500 VDC	TP7	**TP4**	GATE DRV B	TP7
TP5	+90V	TP6	**TP6**	+90V RTN	N/A
TP7	+500V RTN	N/A	**TP8**	BRAKE XSR	TP12/21
TP9	GATE DRV D	TP7	**TP10**	INV DRV A	TP12/21
TP11	INV DRV B	TP12/21	**TP12**	DGND	N/A
TP13	INV DRV C	TP12/21	**TP14**	INV DRV D	TP12/21
TP15	-15V	TP12/21	**TP16**	RAIL SENSE	TP12/21
TP17	RPM	TP12/21	**TP18**	ISO +15 DR	TP12/21
TP19	RAMP	TP12/21	**TP20**	+5V	TP12/21
TP21	DGND	N/A	**TP22**	+15V	TP12/21
TP23	INV O.C. ADJ	TP12/21	**TP24**	COM	N/A
TP25	PHASE	TP24	**TP26**	MAIN	TP24
TP27	FREQ SENSE	TP12/21	**TP28**	FILTERED FREQ	TP12/21

4.6 Mains Power Board

Tables 7-7 and 7-8 show the test points and their voltages or signals, or the resistance on the Mains Power Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-7: Mains Power Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	+24V	TP8
TP2	+24V	TP8
TP6	LINE VOLTAGE	TP8
TP8	PULSE	TP8

Table 7-8: Switch Test Points

TEST POINT	RESISTANCE	GROUND
TP3	Less than 5Ω	TP8
TP4	Less than 5Ω	TP8
TP5	Less than 5Ω	TP8

Note …Measure resistance with circuit breaker (CB1) OFF.

4.7 C-arm Microprocessor Board

Table 7-9 shows the test points and their voltages or signals on the C-arm Microprocessor Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-9: C-arm Microprocessor Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	VCC	TP2	**TP2**	DGND	---
TP3	CLK	TP2	**TP4**	SEL	TP2
TP5	MISO	TP2	**TP6**	MOSI	TP2
TP7	CAD1	TP2	**TP8**	CAD2	TP2
TP9	CAD3	TP2	**TP10**	CAD4	TP2

4.8 Host Microprocessor Board

Table 7-10 shows the test points and their voltages or signals, or the resistance on the Host Microprocessor Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-10: Host Microprocessor Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	R/W	KJ10-2	**TP2**	X-RAY BUTTON	KJ10-2
TP3	PB RST	KJ10-2	**TP5**	RXD0	KJ10-2
TP6	TXD0	KJ10-2	**TP7**	RXD1	KJ10-2
TP8	TXD1	KJ10-2	**KJ1,1**	+8 VDC	KJ10-2
KJ1,3	+20 VDC	KJ10-4	**KJ1,5**	-20 VDC	KJ10-4
KJ10,2	+8 RTN	---	**KJ10,4**	+20 RTN	---
U9,3	+5 VDC	KJ10-2	**U10,3**	+5 VDC	KJ10-2
U11,3	+5 VDC	KJ10-4	**U12,3**	+5 VDC	KJ10-2
U37,3	+5 VDC	KJ10-2			

4.9 Motor / Lamp Control Board

Table 7-11 shows the test points and their voltages or signals, or the resistance on the Motor /Lamp Control Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-11: Motor/Lamp Control Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP10	HIPO 1	TP36	**TP11**	HOPI 1	TP36
TP12	HIPO 2	TP36	**TP13**	HOPI 2	TP36
TP14	DATA	TP36	**TP15**	CLOCK	TP36
TP16	SEL 1	TP36	**TP17**	SEL 2	TP36
TP18	SEL 3	TP36	**TP19**	SEL 4	TP36
TP20	TOWER DOWN	TP36	**TP21**	TOWER UP	TP36
TP22	COMPRESSION RELEASE	TP36	**TP23**	COMPRESSION	TP36
TP24	COMP UP	TP36	**TP25**	COLLIMATOR LAMP	TP36
TP26	ROTATE RIGHT	TP36	**TP27**	ROTATE LEFT	TP36
TP34	LOWER TWR LIMIT SW	TP36	**TP35**	TOP TWR LIMIT SW	TP36
TP36	DGND	N/A	**TP39**	STEREOLOC POT	TP36
TP40	COL LAMP	TP36	**TP41**	COL LAMP RTN	TP36
TP42	C-ARM ANGLE POT	TP36	**TP43**	COMP HEIGHT	TP36
TP44	COMP FORCE	TP36	**TP47**	COMP MOTOR	TP36
TP48	+5V LOGIC	TP36	**TP49**	+5V DISPLAY	TP36
TP50	+12V	TP36	**TP51**	-12V	TP36
TP52	COMP MOTOR +	TP36	**TP57**	CMP SW #	TP36
TP58	CMP SW	TP36	**TP60**	STR ADJ	TP36
CJ26-1	+10V	TP36	**CJ26-3**	+20V	TP36
CJ26-5	-20V	TP36			TP36

4.10 VTA Motor Driver Board

Table 7-12 shows the test points and their voltages or signals, or the resistance on the VTA Motor Driver Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-12: VTA Motor Driver Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND
WJ7-1	+10 VDC	WJ7-2
WJ7-3	+20 VDC	WJ7-4
WJ6-1	+90 VDC	WJ6-3
WJ12-1	120 VAC	WJ12-3

4.11 Rotation Display Board

Table 7-13 shows the test points and their voltages or signals, or the resistance on the Rotation Display Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-13: Rotation Display Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	+5V VCC	U2-8
U2-8	DGND	---

4.12 ±15 V Power Supply Board

Table 7-14 shows the test points and their voltages or signals, or the resistance on the +/-15 V Power Supply Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-14: ±15 V Power Supply Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	-15V	TP2/TP6	**TP2**	DGND	---
TP3	+15V	TP2/TP6	**TP4**	ROTATE C-ARM	TP2/TP6
TP5	ROTATE C-ARM	TP2/TP6	**TP6**	DGND	---

4.13 Power Distribution Board

Table 7-15 shows the test points and their voltages or signals, or the resistance on the Power Distribution Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 7-15: Power Distribution Board Test Point Voltages

TEST POINT	VOLTAGE/SIGNAL	GROUND	TEST POINT	VOLTAGE/SIGNAL	GROUND
TP1	+525V	TP11	**TP2**	+22V	TP11
TP3	+28V	TP11	**TP4**	+22V	TP11
TP5	+16V/40V	TP11	**TP6**	+12 VAC	TP11
TP7	32VAC	TP11	**TP8**	+20V	TP11
TP9	-20V	TP11	**TP10**	+10V	TP11
TP11	DGND	---	**TP12**		

5.0 Tests, Adjustments, and Calibrations

This section covers voltage tests, mechanical adjustments, and calibrations for the components in the M-IV Gantry.

5.1 H. V. Control Board Over-Current / Over-Voltage Adjustment

The following outlines maintenance procedures, checks, and adjustments for the High Voltage Control Board.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power ON. On the High Voltage Control Board, connect a voltmeter to TP8 (+) and TP24 (-).
2. Check that the Small spot over-current reading matches the value in Table 7-3. Make the proper potentiometer adjustment as required.
3. Connect a voltmeter to TP9 (+) and TP24 (-). Check that the Large spot over-current reading matches the value in Table 7-3. Make the proper potentiometer adjustment as required.
4. Connect a voltmeter to TP2 (+) and TP24 (-). Check that the inverter over-current reading matches the value in Table 7-3. Make the proper potentiometer adjustment as required.
5. Connect a voltmeter to TP1 (+) and TP24 (-). Check that the tube over-voltage reading matches the value in Table 7-3. Make the proper potentiometer adjustment as required.

5.2 Filament Control Board Over-Current / Over-Voltage Adjustment

The following outlines maintenance procedures, checks, and adjustments for the Filament Control Board.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power ON. On the Filament Control Board, connect a voltmeter to TP17 (+) and TP7 (-).
2. Check that the small filament over-current reading matches the value for the appropriate tube (Table 7-3). Make the proper potentiometer adjustment as required.
3. Connect a voltmeter to TP16 (+) and TP7 (-). Check that the large filament over-current reading matches the value for the appropriate tube (Table 7-3). Make the proper potentiometer adjustment as required.
4. Connect a voltmeter to TP8 (+) and TP7 (-). Check that the filament over-voltage reading matches the value for the appropriate tube (Table 7-3). Make the proper potentiometer adjustment as required.

5.3 Rotation Angle Calibration

The following procedures require the use of a Digital Protractor.

Set the Rotation Display Potentiometer

1. Zero the Digital Protractor on the base of the M-IV.
2. Holding the protractor against the side of the C-arm, rotate the C-arm until the protractor display reads +22.5° ±0.1°.
3. Set power to the M-IV to OFF.
4. Remove CJ16 from the Motor/Lamp Control Board (refer to Figure 7-1 for board location).
5. Adjust the rotation display potentiometer to its center position (measure 2.5 kΩ from the wiper to one side of the potentiometer).
6. Set backlash tension as follows:
   - Advance backlash gear by (2) teeth.
7. Slide Angle Pot bracket to mesh the backlash and main gears (insure the gears are meshed to full depth of teeth)
8. Back off less than half a tooth of the pot gear to make clearance between the gears.
9. Tighten angle pot bracket screws.
10. Reconnect CJ16 on the Motor/Lamp Control Board.
11. Set power to the M-IV to ON.

Verify Rotation Limit Switches

12. Holding the protractor against the side of the C-arm, rotate the C-arm to +15° ±0.1°.

Note…Refer to Chapter 3, Section 1.0, Switches and Connections throughout the following steps.

13. Set the Host Microprocessor Board DIP switch S4 to position 5 and S6 switch 4 to ON (refer to Figure 7-1 for board location).
14. Press S2 on the Host Microprocessor Board until "ang####" is displayed on LED Display Pad. Press S1 to zero the rotation angle display and save the C-arm position to memory.
15. Rotate the C-arm clockwise until the angle display reads +180° (195°-15°).
16. Monitor the angle display and continue clockwise, the Rotation Limit Switch should engage and shut the unit off before the angle display reads +183° (198°-15°). If it does not, adjust the rotation limit switch as follows:
    - Rotate C-arm to +182° (197°-15°).
    - Manually adjust the rotation limit switch until the Detent arm on the side of the switch is positioned within the detent slot on the side of the pivot tube (it may be necessary to loosen the two screws on the face of the limit switch and/or the top and bottom adjustment screws on the limit switch mounting plate in order to adjust the switch).
    - The M-IV will shut off when the detent arm is positioned within the detent slot on the pivot tube.
17. Manually close the rotation limit switch to return power to the M-IV.
18. Holding the protractor against the side of the C-arm, rotate the C-arm until the protractor display reads 0°.
19. Press S1 on the Host Microprocessor Board to zero the rotation angle display and save the C-arm position to memory.
20. Rotate the C-arm to -90°, and cycle through the collimator sizes to verify no binding occurs. Repeat at +90°.
21. Rotate the C-arm to +180° and verify the angle indication is correct.
22. Verify the C-arm can be moved through a minimum travel of -150° (±1°) to +195° (+1°, -0°).
23. Return C-arm to the 0° position.

Verify Rotation Memory

WARNING!

Observe all safety procedures while making an X-ray exposure.

24. Remove the HV cable from the High Voltage Multiplier test well.
25. Rotate the C-arm to +63° and release a large focal spot / 20 kV / 3 mAs exposure.
26. Rotate the C-arm to -63° and verify the software-initiated detent pause.

5.4 C-Arm Switch Interlocks—Verification

The following procedures verify that the switch sensing circuits of the Motor / Lamp Control Board are functioning. The first test checks that the system senses a stuck switch upon initial power up, the second test checks that C-arm motion is prevented if a movement switch is held during an exposure.

5.4.1 Switch Interlock (Power Up) Check

1. Turn the unit OFF.
2. Have an assistant hold the COMPRESSION UP button on the M-IV C-arm.
3. With the switch held, apply power and enter the Run Mode. Verify that the system displays a "Motion Error 63."
4. Release the switch and clear the error (press reset).
5. Repeat steps 1 through 4 for the following C-arm switches and verify the proper motion error.
   - Compression Down (Motion Error 64)
   - C-arm Up (Motion Error 66)
   - C-arm Down (Motion Error 67)
   - C-arm Rotation—(Motion Error 61)
   - C-arm Rotation—CCW (Motion Error 60)

5.4.2 Switch Interlock (Exposure) Check

1. Set the system for a Manual Mode exposure at 22 kV, 160 mAs. Move the footswitch so that it can be depressed from behind the Operator Console.
2. Press and hold both X-ray Buttons to initiate an exposure. During the exposure, step on the C-arm Up footswitch. Verify that C-arm up movement is prevented during the exposure.
3. Continue to hold the footswitch button down until the exposure stops. Verify that the Run screen message shows "Motion Error 66", and that C-arm up movement is still prevented.
4. Release the footswitch, then press any of the C-arm motion switches (up, down, rotation, etc.). Verify that movement is still prevented.
5. Press the RESET button and verify that the error message is cleared, and that all C-arm motion buttons are active.
6. Repeat this check using the C-arm Down footswitch.

Chapter 8: C-arm Assembly Maintenance

1.0 Parts Identification

The following paragraphs detail the components within the M-IV C-arm Assembly as shown in Figure 8-1 Tubehead Components, Figure 8-2 Beam Limiting Assembly, and Figure 8-3 C-arm Components.

Legend for Figure 8-1

1. X-ray Tube
2. Tubehead Switch Board (2)
3. Filament Protection Board
4. Tubehead Cooling Fan
5. Beam Limiting Assembly
6. Tubehead Motor Driver Board
7. Tubehead Microprocessor Board

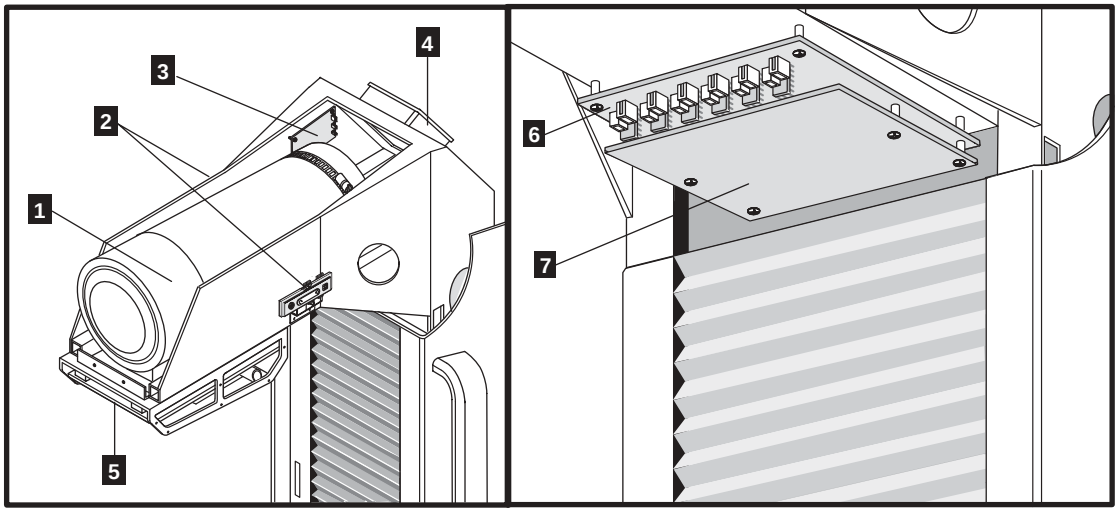


Figure 8-1: Tubehead Components

Legend for Figure 8-2

1. Collimator Blades (4)
2. Collimator Drive Motors (4)
3. Collimator Lamp Assembly
4. Mirror Assembly
5. Lamp / Mirror Drive Motor
6. Dual Filter Motor
7. Filter Drive Motor
8. Beam Limiting Assembly Chassis
9. Fan Assembly

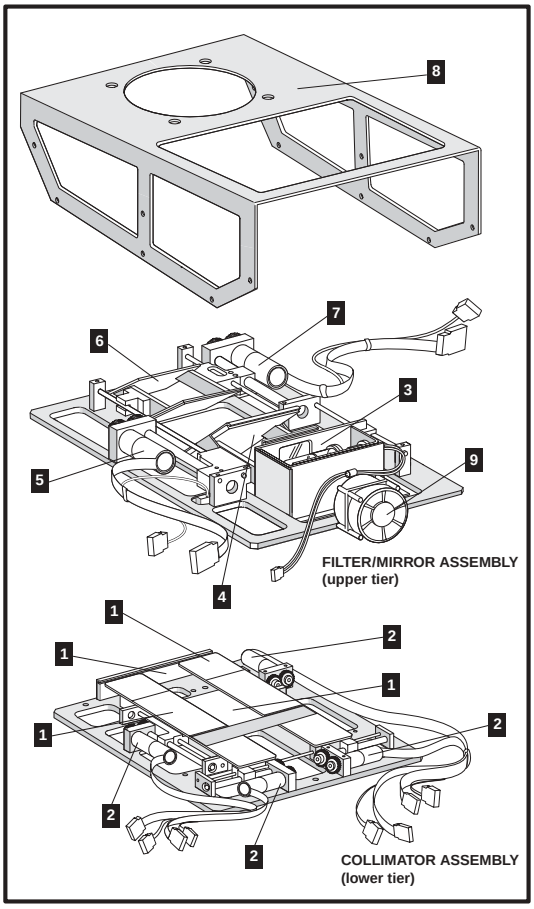


Figure 8-2: Beam Limiting Assembly

Legend for Figure 8-3

1. Compression / AEC Position Display Boards (2)
2. Compression Accessory Detect Board
3. Compression Clutch and Clutch Brake Assembly
4. Manual Compression Handwheels
5. Compression Thickness Potentiometer
6. Compression Drive Brake
7. Compression Drive Motor
8. Compression Drive Chain
9. IRSD

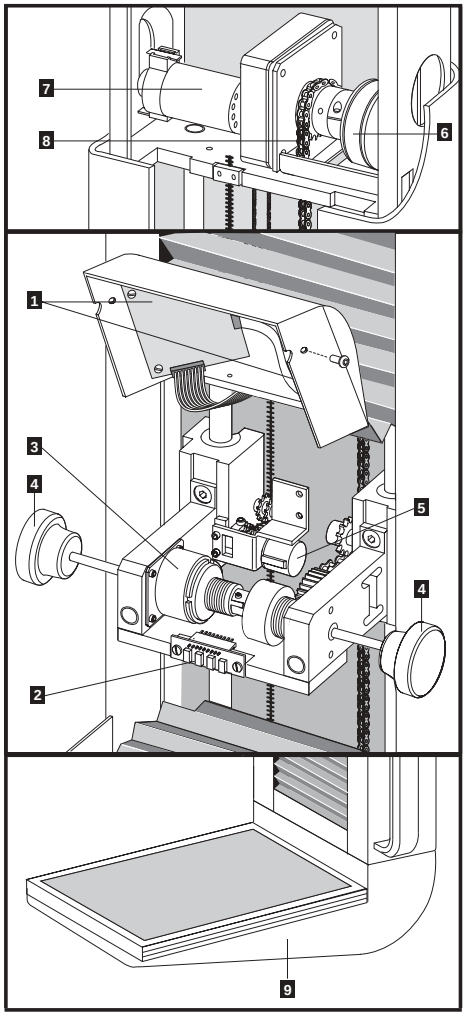


Figure 8-3: C-arm Components

2.0 Remove and Replace—Tubehead Components

Before performing any remove and replace procedure, ensure that all electrical safety precautions are met. Power down the unit, set the circuit breaker to OFF, then disengage the voltage source. Perform the applicable lock-out or tag-out procedure at the source junction box before removing any covers.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

2.1 Beam Limiting Assembly

The Beam Limiting Assembly mounts below the x-ray tube inside the tubehead enclosure. The Beam Limiting Assembly is a 2-tier mechanism; an upper tier containing the dual filter changer and the mirror/lamp assembly, and a lower tier containing the 4-blade automatic beam collimator. The lower tier must be removed before the upper tier. The procedure below explains how to remove the Beam Limiting Assembly.

1. Turn the unit OFF, then remove the top and bottom tubehead covers.
2. Disconnect the Lamp Cooling Fan power cable from the Filament Protection Board.
3. Disconnect the cables listed in Table 8-1 from the Tubehead Controller Board:
4. Remove the hardware that secures the lower tier (collimator blades) to the Beam Limiting Assembly chassis. Carefully remove the collimator assembly and set it aside. Use care not to damage the lead lining on the collimator blades.
5. Remove the hardware that secures the upper tier (mirror and filter assemblies) to the Beam Limiting Assembly chassis. Carefully remove the mirror and filter assembly and set it aside.

Note …It is possible to install cables DJ1, DJ2, DJ3, and DJ4 incorrectly. To avoid this, note the cable position and orientation before disconnecting.

Table 8-1: Tubehead Controller Board Cables

CONNECTOR	CABLE DESCRIPTION
DJ1	Left Collimator Blade Position Detect
DJ2	Left Collimator Blade Motor
DJ3	Front Collimator Blade Position Detect
DJ4	Front Collimator Blade Motor
DJ5	Filter Assembly Motor
DJ6	Filter Assembly Position Detect
DJ7	Mirror / Lamp Assembly Position Detect
DJ8	Mirror / Lamp Assembly Motor
DJ9	Rear Collimator Blade Position Detect
DJ10	Rear Collimator Blade Assembly Position Detect
DJ11	Right Assembly Position Detect
DJ12	Right Assembly Position Detect

CAUTION!

DO NOT touch either filter on the dual filter assembly. Filter contact with bare skin, or other materials, can cause artifacts in a developed film.

6. Remove the hardware that secures the Beam Limiting Assembly chassis to the tubehead frame to remove the chassis.
7. Reverse these steps to install the replacement Beam Limiting Assembly. Ensure the Lamp Harness Cable is securely routed through the cable clamp as shown in Figure 8-4.
8. Perform the procedures below before releasing the unit to the user (refer to Chapter 4):
   - Section 3.1, X-ray Beam Alignment Check and Adjustment
   - Section 3.2, Light Field Illuminance Check and Adjustment
   - Section 3.3, Light Field Alignment Check and Adjustment
   - Section 3.4, Light Field Edge Contrast Check
   - Section 4-9, Check—Light Field Edge Contrast
   - Section 5.2, X-ray Tubehead Leakage Check

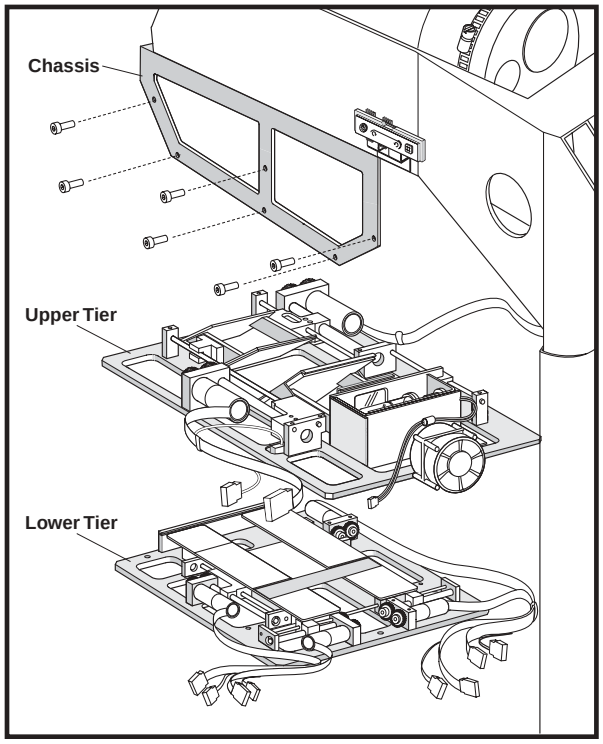


Figure 8-4: Beam Limiting Assembly—Removal

2.2 X-ray Tube

The x-ray tube mounts to the tubehead frame. Note that the Beam Limiting Assembly must be removed to access the x-ray tube mounting hardware.

1. Turn the unit OFF, then remove the top and bottom tubehead covers. Remove the Beam Limiting Assembly to access the x-ray tube mounting hardware.
2. Disconnect the high voltage cable and the filament cable from the rear of the x-ray tube.
3. Loosen the band clamp, near the rear end of the x-ray tube, so that it can be slipped over the rear edge of the x-ray tube.
4. Remove the x-ray tube mounting hardware from beneath the tubehead frame.
5. Slide the x-ray tube out of the tubehead frame from the front.
6. Reverse this procedure to install the replacement x-ray tube.
7. Verify that DIP Switch (S6) is set properly for the make and model x-ray tube (refer to Chapter 3, Section 4.2, Setting—X-ray Tube Type).
8. Perform the following Exposure System Adjustments / Calibrations, and AEC Calibration before releasing unit to the user (refer to Chapter 3):
   - Section 4.3, Tube Bias Adjustment
   - Section 4.4, Tube Current (mA) Adjustment
   - Section 4.5, Tube Voltage Potential (kV) Adjustment
   - Section 5.0, Automatic Exposure Control Calibration (all applicable sections)
9. Perform the following Checks and Adjustments before releasing unit to the user (refer to Chapter 4):
   - Section 2.1, Half Value Layer Check
   - Section 2.2, Reproducibility and Linearity (Manual Mode) Check
   - Section 3.1, X-ray Beam Alignment Check and Adjustment
   - Section 3.2, Light Field Illuminance Check and Adjustment
   - Section 3.3, Light Field Alignment Check and Adjustment
   - Section 3.4, Light Field Edge Contrast Check
   - Section 4-9, Check—Light Field Edge Contrast
   - Section 5.2, X-ray Tubehead Leakage Check
10. Perform the following Compliance Requirements before releasing the unit to the user.
    - Affix new compliance label
    - Complete FDA 2579C form (tube exchange).

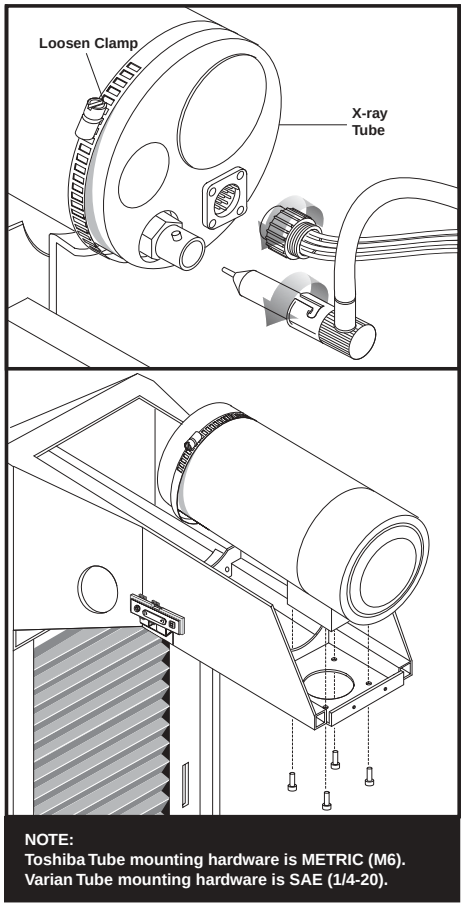


Figure 8-5: X-ray Tube—Removal

2.3 Tubehead Cooling Fan

The tubehead cooling fan mounts to the tubehead frame, on the bulkhead directly behind the x-ray tube.

1. Remove the tubehead top cover. Locate the tubehead cooling fan on the rear of the tubehead frame.
2. Disconnect the fan power cable.
3. Remove all cable ties from the power cable, then remove the hardware that secures the cooling fan mounting bracket to the tubehead frame. Lift the fan and bracket assembly out of the unit.
4. If necessary, remove the hardware that secures the mounting bracket to the cooling fan.
5. Reverse these steps to install the replacement cooling fan.
6. Perform the X-ray Tubehead Leakage Check before releasing the unit to the user (refer to Chapter 4, Section 5.2).

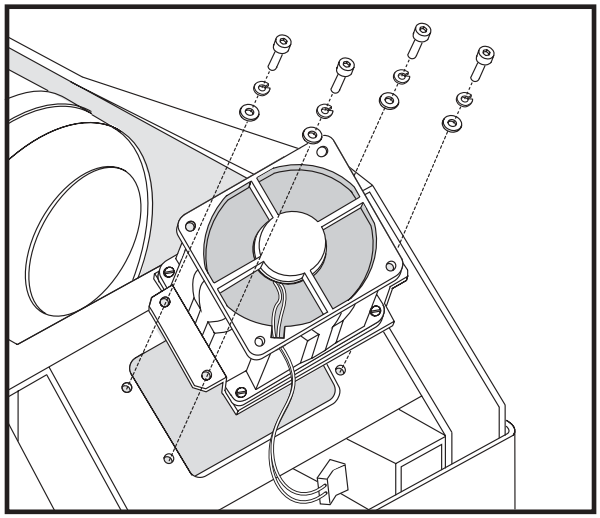


Figure 8-6: Tubehead Cooling Fan—Removal

2.4 Filament Protection Board

The Filament Protection Board mounts to the left rear side tubehead frame, directly behind the x-ray tube.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Remove the tubehead top cover. Locate the Filament Protection Board near the left rear side of the tubehead frame.
2. Remove all cables from their board connectors. Use Table 8-2 to determine jumper locations during reinstallation:

Table 8-2: Filament Protection Board Cables

CONNECTOR	CABLE DESCRIPTION
XJ1	from Filament Board
XJ2	to X-ray Tube
XJ3	from C-arm Interlock Interface board
XJ4	to Fan
XJ5	to Tube Temp
XJ6	to Lamp / Lamp Fan

3. Remove the mounting hardware that secures the Filament Protection Board to the tubehead frame. Lift the board off of the standoffs.
4. Reverse these steps to install the replacement Filament Protection Board.
5. Perform the X-ray Tubehead Leakage Check (refer to Chapter 4, Section 5.2).
6. Perform the Tube Current (mA) Adjustment before releasing the unit to the user (refer to Chapter 3, Section 4.4)

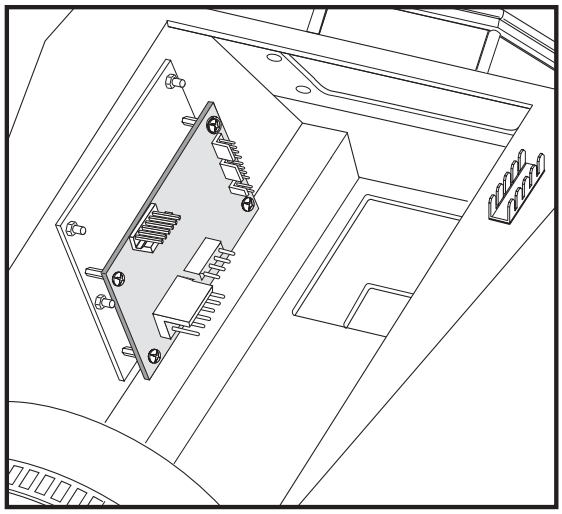


Figure 8-7: Filament Protection Board—Removal

2.5 Tubehead Switch Boards

There are two Tubehead Switch Boards; one on either side of the tubehead. The Switch Boards mount onto brackets which are then mounted on the side of the tubehead frame.

1. Remove the top and bottom tubehead covers.
2. Locate the Switch Board (one on each side of the tubehead frame) that requires replacement.
3. Remove all cables from their board connectors. Note each cable location for replacement.
4. Remove the hardware that secures the Switch Board mounting bracket to the tubehead frame.
5. Lift the Switch Board and mounting bracket off the tubehead frame as an assembly.
6. Reverse these steps to install the replacement Switch Board.
7. Verify all switch functions before releasing the unit to the user (refer to Chapter 3, Section 2.2, Functional Checks—C-arm Movement System, Steps 3 and 4, Section 2.3, Functional Checks—Collimator Lamp Button, and Section 2.4, Functional Checks—Collimator Override Switch).

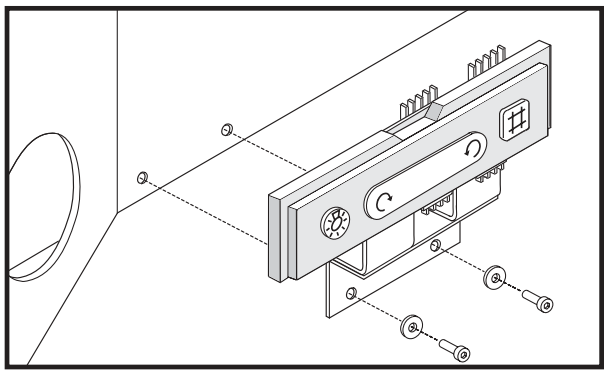


Figure 8-8: Tubehead Switch Board—Removal

2.6 Tubehead Microprocessor and Tubehead Motor Driver Board

The Tubehead Motor Driver Board mounts to the bottom of the tubehead frame, directly behind the beam limiting assembly. The Tubehead Microprocessor mounts to standoffs on the Tubehead Motor Driver Board.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Remove the top and bottom tubehead covers. Locate the Tubehead Microprocessor Board, which is mounted to the Tubehead Motor Driver Board, beneath the tubehead frame (to the rear of the beam limiting assembly).
2. Remove the hardware that secures the Tubehead Microprocessor to the standoffs (attached to the Tubehead Motor Driver Board).
3. Carefully pull the connector (on the Tubehead Microprocessor) from its mating socket (on the Tubehead Motor Driver Board).
4. Disconnect all cables from their connectors on the Tubehead Motor Driver Board. Note each location for replacement.
5. Remove the hardware that secures the Tubehead Motor Driver Board to the tubehead frame. Carefully remove the board from the tubehead.
6. Reverse these steps to install the replacement Tubehead Microprocessor and the Tubehead Motor Driver Board.
7. Perform the following Checks and Adjustments before releasing the unit to the user (refer to Chapter 4):
   - Section 3.2, Light Field Illuminance Check and Adjustment
   - Section 3.3, Light Field Alignment Check and Adjustment)
   - Section 3.4, Light Field Edge Contrast Check
   - Section 4-9, Check—Light Field Edge Contrast
   - Section 2.1, Half Value Layer Check
   - Section 2.2, Reproducibility and Linearity (Manual Mode) Check
   - Section 5.2, X-ray Tubehead Leakage Check

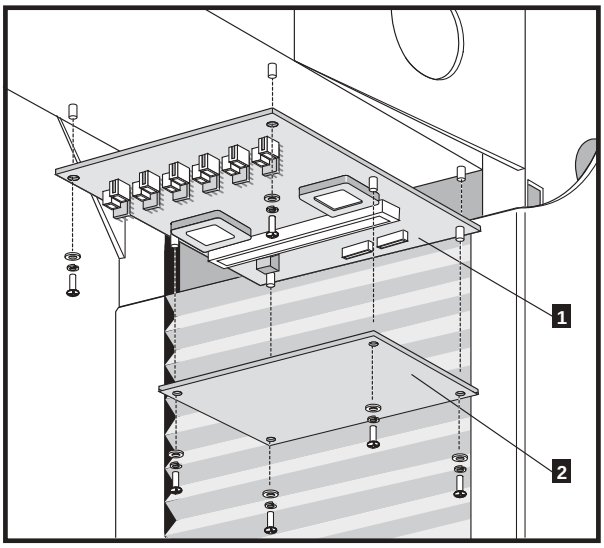


Figure 8-9: Tubehead Processor and Motor Control Boards—Removal

3.0 Remove and Replace—Compression Components

Before performing any remove and replace procedure, ensure that all electrical safety precautions are met. Power down the unit, set the circuit breaker to OFF, then disengage the voltage source. Perform the applicable lock-out/tag-out procedure at the source junction box before removing any covers.

3.1 Compression Thickness Potentiometer

The Compression Thickness Potentiometer is a 5,000 ohm, 10-turn potentiometer that mounts to the left side bulkhead of the Compression Device frame.

1. Turn power OFF, then remove the top and bottom Compression Device covers (as per Chapter 5, Section 2.3, Compression Device Covers). Use care not to damage the Compression Device bellows.
2. Remove the lower bellows assembly as per Section 3.2, Upper and Lower Bellows Assemblies, Steps 1, 2 and 4.
3. Loosen two allen screws securing the Compression Timing Belt to the Bearing Block Assembly (refer to Figure 8-10). Remove timing belt from the bottom clamp.

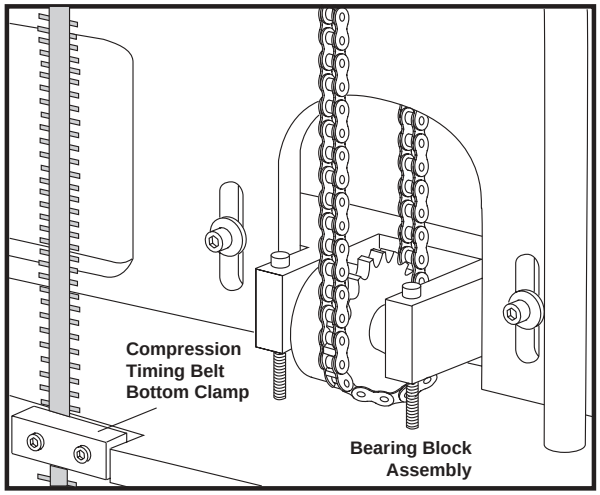


Figure 8-10: Compression Timing Belt—Removal

4. Gently thread timing belt up and out of the pulleys. Check timing belt, if damaged, order new belt (PN 3-230-4002) and replace as per Section 3.7, Timing Belt.
5. Loosen the clamp screw (A) on the end of the potentiometer (B) shaft. Remove the clamp and the sprocket (C) together (refer to Figure 8-11).
6. Remove the hex nut (D) that secures the potentiometer to the mounting bracket (E). Slide the potentiometer off the bracket.

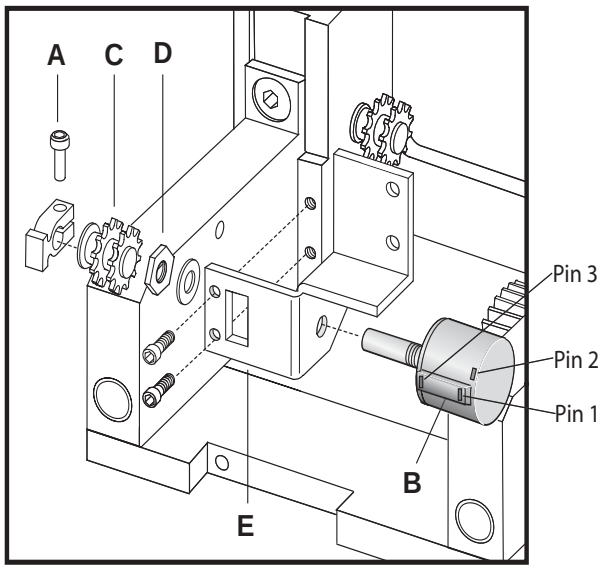


Figure 8-11: Compression Thickness Potentiometer—Removal

7. De-solder the three wires connections (white, red, and black) from the posts on the potentiometer. Note the color wire for each post.
8. Reverse steps 3 through 7 to install the replacement potentiometer.
9. Perform the Section 6.4, Compression Thickness Potentiometer Mechanical Adjustment procedures.
10. Replace the lower bellows assembly.
11. Replace the compression device assembly upper and lower covers.
12. Perform the Section 6.1, Compression Force Calibration procedures.
13. Perform the Section 6.2, Compression Thickness Potentiometer Calibration procedures.

3.2 Upper and Lower Bellows Assemblies

1. Remove IRSD as per Chapter 5, Section 2.5, Image Receptor Support Device (IRSD) Covers, Steps 1 and 2.
2. Unscrew and remove two bellows rods. Refer to Figure 8-12.

Note …To access the bellows screws (for both upper and lower) pull cover and bellows away from C-Arm easily, ensure bellows clears sub frame.

3. Remove three screws securing upper bellows assembly to C-Arm sub frame. Carefully remove assembly.
4. Remove three screws securing lower bellows assembly to bearing block assembly. Carefully remove assembly.
5. Reverse procedures to replace the bellows assemblies.

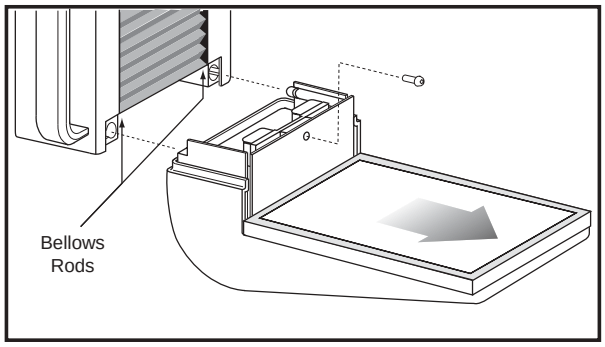


Figure 8-12: Removing the Bellows Rods

3.3 Compression/AEC Position Display Board

The Compression/AEC Position Display Boards (left and right, see Figure 8-13) provide readouts for compression thickness, compression force, and the position of the AEC Sensor Board. These display boards mount to the inside of the top Compression Device cover.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power OFF, then remove the top Compression Device cover as per Chapter 5, Figure 2.3. Use care not to damage the Compression Device bellows.
2. Disconnect the cable connectors from the Compression / AEC Position Display Board to be removed (left or right).
3. Remove the hardware that secures the Compression / AEC Position Display Board (left or right) to be removed to the standoffs on the top cover.
4. Reverse these steps to install the replacement display board.
5. Perform the Section 6.1, Compression Force Calibration procedures.

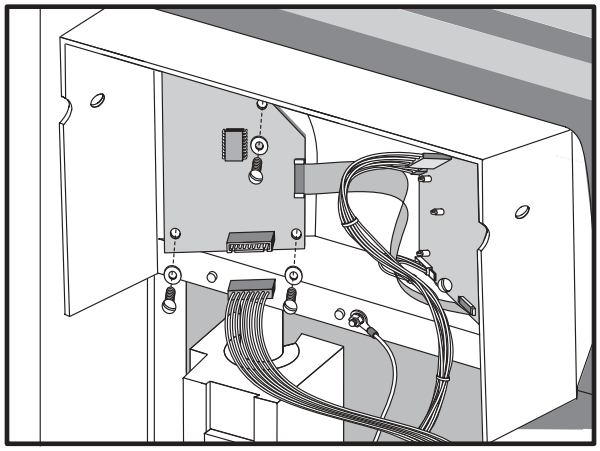


Figure 8-13: Compression /AEC Position Display Board—Removal

3.4 Compression Accessory Detect Board

The Compression Accessory Detect Board (Figure 8-14) has four sensors that detect the type of Compression Paddle installed on the Compression Device. This board mounts to the bottom Compression Device frame, near the front.

1. Turn power OFF, then remove the top and bottom Compression Device covers (as per Chapter 5, Section 2.3, Compression Device Covers). Use care not to damage the Compression Device bellows.
2. Remove the harness connector from ADJ1 on the board.
3. Remove the hardware that secures the Compression Accessory Detect Board to the Compression Device frame.
4. Reverse these steps to install the replacement detect board.
5. Perform the Compression Accessory Detect Board Verification (Section 6.6) before releasing the unit to the user.

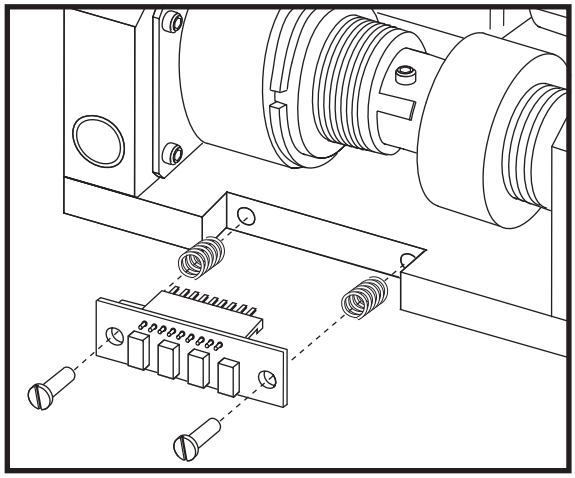


Figure 8-14: Compression Accessory Detect Board—Removal

3.5 Compression Clutch and Clutch Brake Assembly

The Compression Device houses a clutch and clutch brake assembly for patient safety during compression (Figure 8-15). The clutch brake prevents Compression Device backlash after motorized compression; the clutch stops manual compression before the maximum compression force is exceeded.

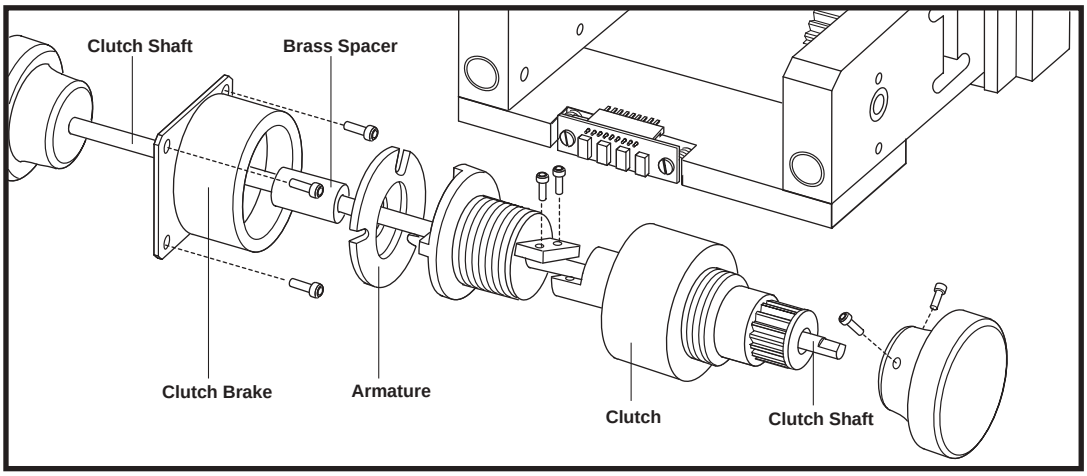


Figure 8-15: Compression Clutch and Clutch Brake—Removal

1. Turn power OFF, then remove the top and bottom Compression Device covers. Use care not to damage the Compression Device bellows.
2. Loosen the set screws that secure the right side compression knob to the clutch shaft. Slide the knob off the shaft.
3. Loosen the screws that secure the locking bar to the clutch shaft. Slide the clutch shaft out of the Compression Device from the left side.
4. Lift the clutch, the armature, and the brass spacer from the Compression Device. If it is only necessary to replace the clutch, skip step #5 and #6.
5. Remove the screws that secure the clutch brake to the left side Compression Device frame. Remove the clutch brake harness connector from the main harness.
6. Install the replacement clutch brake and tighten the mounting screws. Connect the clutch brake harness to the main wiring harness.
7. Slide the clutch shaft into the Compression Device from the left side the shaft end protrudes through the opening in the clutch brake. Slide the brass spacer (raised edge first) over the shaft and into the brake.
8. Place the armature on the end of the replacement clutch (machined side toward the brake). Slide the clutch shaft through the clutch, then out the opposite side of the Compression Device. Install the previously removed knob and tighten the set screws.
9. Adjust the clutch shaft by sliding it back and forth until both knobs are equal distances from the sides of the Compression Device.
10. Place a 0.015" feeler gauge (or shim stock) between the armature and the clutch brake. Spread the clutch mechanism so that the clutch sprocket is pressed firmly against the chain gears (at right), and that the armature is pressed against the feeler gauge.
11. Tighten the locking bar mounting hardware, then remove the feeler gauge. Check that the gap between the armature and the clutch is 0.010" (minimum) to 0.020" (maximum). Verify that there is no left-to-right "play" in the clutch.
12. Replace the covers and verify compression movement functions.
13. Perform the Compression Chain Tension Adjustment (Section 6.3), the Compression Thickness Sensor Adjustment (Section 6.2), and the Compression Force Adjustment (Section 6.1) before releasing the unit to the user.

3.6 Compression Motor and Motor Brake

The Compression Motor drives the compression chain through a series of gears to move the Compression Device up or down. The Compression Motor Brake holds the chain in place to prevent Compression Device backlash (Figure 8-16).

1. Turn power OFF, then remove the top and bottom Compression Device covers. Remove the three screws that secure the top bellow to the C-arm frame, then carefully remove the top bellow.
2. Remove the lower tubehead enclosure, then remove the Tubehead Microprocessor and the Tubehead Controller Board from the tubehead frame.
3. Manually move the Compression Device to center it on the C-arm. Disconnect the master link on the drive chain, then remove the drive chain from around the Compression Motor sprocket.
4. Disconnect the input power wires from the rear of the compression motor. Note the polarity for replacement purposes.
5. Remove the two screws that secure the compression motor bracket to the C-arm frame. Pull the compression motor and brake out of the C-arm as an assembly.
6. Loosen the set screws that secure the motor shaft to the motor sprocket. Pull the brake, with the sprocket, off the motor shaft.
7. Remove the screws that fasten the compression motor to the mounting bracket. Mount the replacement motor onto the bracket.
8. Reverse these procedure to install the replacement compression drive motor and brake assembly.
9. Perform the procedures below before releasing the unit to the user:
   - Chapter 7, Section 6.1, Compression Force Calibration
   - Chapter 7, Section 6.2, Compression Thickness Potentiometer Calibration
   - Chapter 7, Section 6.3, Compression Chain Tension Adjustment
   - Chapter 4, Section 5.2, X-ray Tubehead Leakage Check

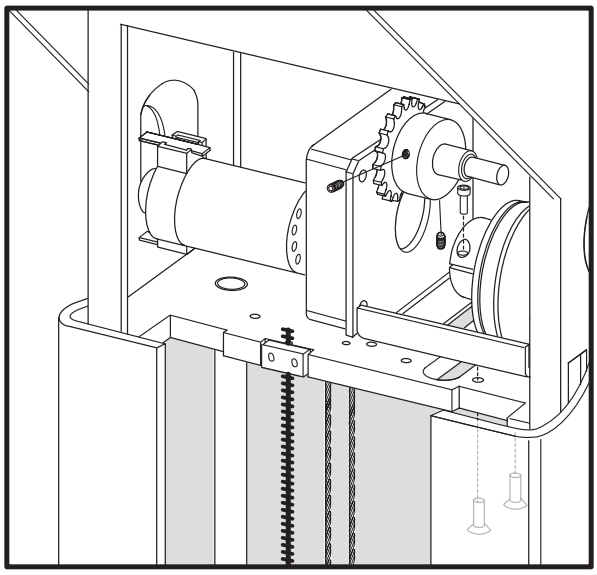


Figure 8-16: Compression Drive Assembly—Removal

3.7 Timing Belt

Perform this procedure only if the compression timing belt has been damaged (Figure 8-17).

1. Loosen two screws securing the timing belt in the upper clamp block. Remove belt and discard.
2. Insert the new timing belt through the upper clamp on the Tubehead Support Plate. Apply Blue Loctite 242 and retighten screws.
3. Perform the Compression Display Potentiometer Adjustment. Refer to Section 6.4.

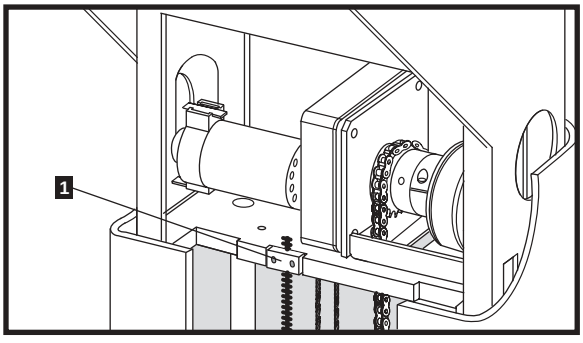


Figure 8-17: Timing Belt—Removal

4.0 Remove and Replace—IRSD Components

Before performing any remove and replace procedure, ensure that all electrical safety precautions are met. Power down the unit, switch OFF the input power circuit breaker, then disengage the voltage source. Perform the applicable lock-out/tag-out procedure at the source junction box before removing any covers.

4.1 Image Receptor Accessory Detect Board

The Image Receptor Accessory Detect Board is mounted to the rear frame IRSD (Figure 8-18). Access this board by removing the IRSD bottom cover.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power OFF, then remove the bottom IRSD cover.
2. Locate the detect board on the right side of the frame (as viewed from the rear), then disconnect the wiring harness from AFJ1.
3. Remove the four mounting screws, then lift the board out of the IRSD.
4. Reverse this procedure to install the replacement Image Receptor Detect Board.
5. Perform the following procedures before returning unit to service:
   - Chapter 8, Section 6.7, Image Receptor Detect Board Verification

4.2 C-arm Rotation Switch Board

A C-arm Rotation Switch Board is mounted to the rear frame of the IRSD. Access this board by removing the IRSD bottom cover.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power OFF, then remove the bottom IRSD cover.
2. Locate the switch board near the center of the frame (as viewed from the rear), then disconnect the wiring harness from AAJ2.
3. Loosen the two screws that secure the switch board bracket to the IRSD frame, then pull the entire assembly out of the unit.
4. Remove the screws that fasten the switch board to the bracket.
5. Reverse these steps to install the replacement C-arm Rotation Switch Board.
6. Perform the following procedures before returning unit to service:
   - Chapter 3, Steps 3 and 4 of Section 2.2, Functional Checks—C-arm Movement System,

4.3 Bucky Driver Board

The Bucky Driver Board is mounted to the rear frame of the IRSD (Figure 8-18). Access this board by removing the IRSD bottom cover.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power OFF, then remove the bottom IRSD cover.
2. Locate the driver board near the left side of the frame (as viewed from the rear), then disconnect the wiring harnesses from ARJ1, ARJ2, and ARJ3.
3. Remove the hardware that secures the Bucky Driver Board to the IRSD frame, then lift the board out of the unit.
4. Reverse this procedure to install the replacement Bucky Driver Board. Verify operation of the Bucky Device.
5. Perform the following procedures before returning unit to service:
   - Chapter 4, Section 5.1, IRSD Leakage Check

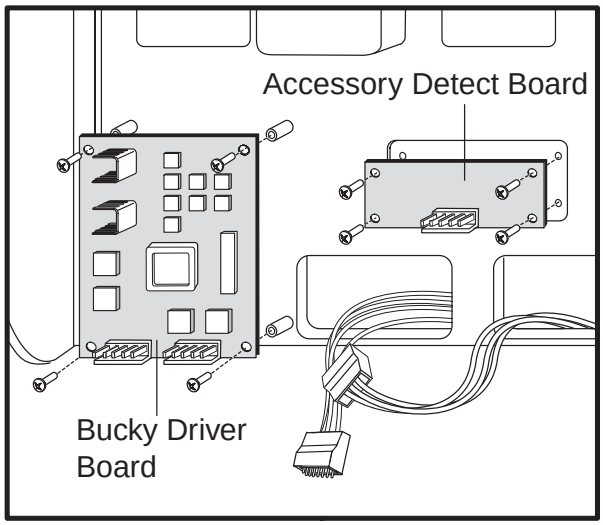


Figure 8-18: IRSD Components (rear frame)—Removal

4.4 Image Receptor Microprocessor

The Image Receptor Microprocessor is mounted beneath the breast tray on the IRSD (Figure 8-19). Access this board by removing the IRSD bottom cover.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power OFF, then remove the bottom IRSD cover.
2. Locate the microprocessor board beneath the breast tray (as viewed from below), then disconnect the wiring harnesses from FJ1, FJ2, FJ3, FJ4, FJ7, FJ8, and FJ11.
3. Remove the ribbon cable (from AEC Detector Assembly) from FJ5 on the Microprocessor.
4. Remove the mounting hardware that secures the microprocessor to the standoffs on the bottom of the breast tray, then remove the board from the unit.
5. Reverse these steps to install the replacement Image Receptor Microprocessor Board.
6. Perform the following procedures before returning unit to service:
   - Chapter 4, Section 5.1, IRSD Leakage Check

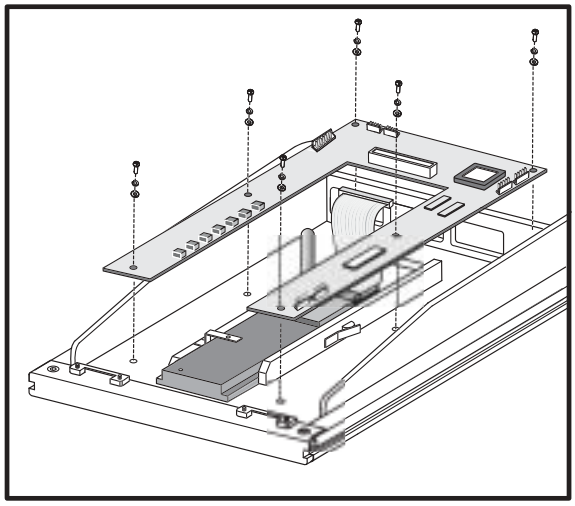


Figure 8-19: IRSD Components (breast tray)—Removal

4.5 AEC Detect Board

The AEC Detect Board Assembly is mounted beneath the breast tray on the IRSD (Figure 8-20). Access this board by removing the IRSD bottom cover.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

1. Turn power OFF. Remove the bottom IRSD cover, and the front rail of the breast tray.
2. Remove the ribbon cable from FJ5 on the Microprocessor Board.
3. Slide the entire AEC Detect Assembly out from the front of the IRSD.
4. Reverse these steps to install the replacement AEC Detect Board Assembly.
5. Perform the Image Receptor Leakage Test (Chapter 4, Section 5.1, IRSD Leakage Check).
6. Perform the following procedures before returning unit to service:
   - Chapter 3, Section 5.0, Automatic Exposure Control Calibration
   - Chapter 4, Section 2.3, Reproducibility (Auto-Time Mode) Check
   - Chapter 4, Section 2.4, Reproducibility (Auto-kV Mode) Check

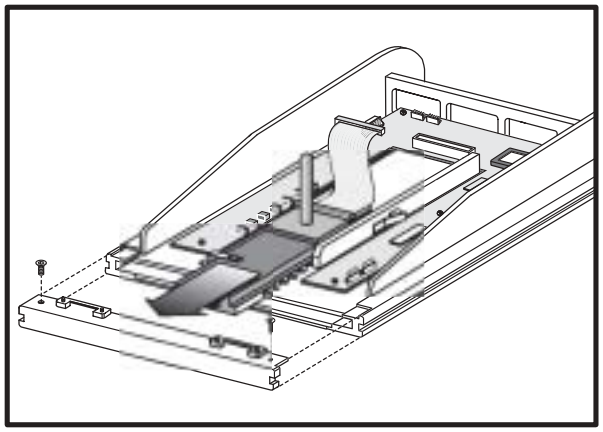


Figure 8-20: AEC Detect Board—Removal

5.0 Test Points

Use the following test point tables as a guide for troubleshooting the circuit boards in the M-IV C-arm Assembly.

CAUTION!

Be aware of the damage static electricity can inflict on electronic components. Always wear a grounded electrostatic discharge strap when handling static sensitive components.

5.1 Filament Protection Board

Table 8-3 shows the test points and their voltages/signals on the Filament Protect Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 8-3: Filament Protection Board Test Point Voltages

TP#	Voltage/Signal	GND TP#	TP#	Voltage/Signal	GND TP#
TP1	TSTPT GRID	TP2	**TP2**	TSPT MA	TP3
TP3	TSPT GND	—	**TP4**	TSTPT SM	TP2
TP5	TSTPT LG	TP2			

5.2 Tubehead Microprocessor

Table 8-4 shows the test points and their voltages/signals on the Tubehead Microprocessor. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 8-4: Tubehead Microprocessor Test Point Voltages

TP#	Voltage/Signal	GND TP#	TP#	Voltage/Signal	GND TP#
TP1	D2ACLK	TP41	**TP2**	D2AIN	TP41
TP3	FILTER	TP41	**TP4**	MIRROR	TP41
TP5	REAR	TP41	**TP6**	FRONT	TP41
TP7	RIGHT	TP41	**TP8**	LEFT	TP41
TP40	VCC	TP41	**TP41**	DGND	—
TP42	R/W	TP41			

5.3 Tubehead Motor Driver Board

Table 8-5 shows the test points and their voltages/signals on the Tubehead Motor Driver Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 8-5: Tubehead Motor Driver Board Test Point Voltages

TP#	Voltage/Signal	GND TP#	TP#	Voltage/Signal	GND TP#
TP9	LTA	TP34	**TP10**	LTB	TP34
TP12	LTM	TP36	**TP13**	RTM	TP36
TP15	RTA	TP34	**TP16**	RTB	TP34
TP17	FTM	TP36	**TP19**	FTA	TP34
TP20	FTB	TP34	**TP21**	RM	TP36
TP23	RA	TP34	**TP24**	RB	TP34
TP25	MM	TP36	**TP27**	MA	TP34
TP28	MB	TP34	**TP29**	FLM	TP36
TP31	FLA	TP34	**TP32**	FLB	TP34
TP33	+8 V P8	**TP34**	**TP34**	DGND	—
TP35	-20 V N20	TP36	**TP36**	AGND	—
TP37	+20 V P20	TP36	**TP38**	FLH	TP34
TP39	MH	TP34	**TP40**	RH	TP34
TP41	FTH	TP34	**TP42**	RTH	TP34
TP43	LTH	TP34			

5.4 Compression / AEC Position Display

Table 8-6 shows the test points and their voltages or signals on the Compression / AEC Position Display Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 8-6: Compression/AEC Position Display Test Point Voltages

TP#	Voltage/Signal	GND TP#	TP#	Voltage/Signal	GND TP#
TP3	FORCE	U5-4	**TP4**	-12 V	U5-4
TP5	+12 V	U5-4	**TP6**	+5 V	U5-4
U5-4	DGND	—	**TP16**	RTB	U5-4

5.5 Image Receptor Microprocessor

Table 8-7 shows the test points and their voltages or signals on the Image Receptor Microprocessor. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 8-7: Image Receptor Microprocessor Test Point Voltages

TP#	Voltage/Signal	GND TP#	TP#	Voltage/Signal	GND TP#
TP1	ACC	TP23	**TP2**	DET4	TP23
TP3	DET3	TP23	**TP4**	DET2	TP23
TP5	-DET1	TP23	**TP6**	BUSY	TP23
TP7	AOUT	TP22	**TP8**	CLK	TP23
TP9	SAMPLE	TP23	**TP10**	CAL	TP23
TP11	DATA	TP23	**TP12**	R/W	TP23
TP13	AUTO	TP23	**TP14**	EXP	TP23
TP15	POS1	TP23	**TP16**	POS3	TP23
TP17	POS4	TP23	**TP18**	POS5	TP23
TP19	POS6	TP23	**TP20**	POS7	TP23
TP21	+8 V	TP23	**TP22**	AGDN	—
TP23	DGDN	—	**TP24**	POS2	TP23
TP24	-20 V	TP22	**TP26**	+20 V	TP22
TP27	POS STB	TP23	**TP28**	SCK	TP23
TP29	READY	TP23			

5.6 Bucky Interface Board

Table 8-8 table shows the test points and their voltages or signals on the Bucky Interface Board. When taking measurements, connect the voltmeter ground appropriately according to the table below.

Table 8-8: Bucky Interface Board Test Point Voltages

TP#	Voltage/Signal	GND TP#	TP#	Voltage/Signal	GND TP#
TP1	AGND	—	**TP2**	MISO	TP1
TP3	DRV	TP1	**TP4**	HOME	TP1
TP5	END	TP1	**TP6**	HV	TP1
TP7	MOSI	TP1			

6.0 Tests, Adjustments, and Calibrations

This section covers voltage tests, mechanical adjustments, and calibrations for the components in the M-IV C-arm.

6.1 Compression Force Calibration

Perform this calibration procedure after servicing or replacing the Compression Clutch Assembly or the Compression Drive Assembly.

1. Apply power to the M-IV, then rotate the C-arm to the 0 degree position.
2. Set the M-IV for the Calibration Mode (S6 switch 4 = ON). Set the Host for the Compression Height and Force Calibration (S4 = 5; S6 switch 8 = OFF). Toggle Switch (S2) until the Host Board Display reads: C20f####.
3. Install an 18 x 24 cm Bucky on the IRSD. Place a force gauge in the approximate center and cover with a folded towel for absorption.
4. Install the 18 x 24 cm Compression Paddle onto the Compression Device. Manually apply compression onto the towel and gauge until the gauge display indicates 20 pounds of force.
5. Press Switch (S1) on the Host Microprocessor to record the setting to memory. Toggle Switch (S2) until the Host Board Display reads: C40f####.
6. Manually apply compression onto the towel and gauge until the gauge display indicates 40 pounds of force. Press Switch (S1) on the Host board to save the setting.
7. Set the system back for normal operation. Apply compression onto the force gauge and compare the force gauge reading with the Compression Force Display on the Compression Device. The readings should match within ±4.5 pounds (20 N).
8. Release the gauge from compression, then repeat step #7 with the C-arm rotated first 90, and then rotated 180.

6.2 Compression Thickness Potentiometer Calibration

Perform this calibration procedure after servicing or replacing the Compression Thickness Potentiometer.

Note …The compression thickness MUST BE calibrated for each of the compression paddle/image receptor combinations used with the machine (i.e., 18 x 24 cm Paddle with M-IV Bucky). If the user wishes to use a compression paddle with a different image receptor, that paddle/receptor combination MUST BE calibrated by performing the procedure that follows.

1. If not already done, apply power to the M-IV system, then open the right side Gantry door. Set the Host Microprocessor for Calibration Mode: S6 switch 4 = ON.
2. Select Motor Control calibration by placing S6 switch 8 = OFF, and turning the rotary switch (S4) to position #5. On the Host Microprocessor, toggle switch (S2) until the Host Display reads: Cht# ###.
3. If not already done, install the 18 x 24 cm Bucky device and 18 x 24 cm paddle onto the compression Device.
4. Center 5 cm of B.E.M. on the IRSD, and orient it so that it is even with the chest wall edge of the image receptor. Move the compression device down until the compression force display indicates 30 pounds of force (133.5 N).
5. On the Host Microprocessor, press (S1) to calibrate the compression thickness for the installed paddle/receptor combination.
6. Raise the compression device off of the B.E.M., then lower it again until the force reading indicates 30 lb (133.5 N). Verify that the thickness reading indicates 5 cm.
7. Remove the Bucky device and install the Magnification Table. Install a magnification paddle on the compression device.

8. Center 5 cm of B.E.M. on the Magnification Table and orient it so that it is even with the chest wall edge of the image receptor.
9. Move the compression device down until the compression force display indicates 30 pounds of force (133.5 N). On the Host Microprocessor, press (S1) to calibrate the compression thickness for the installed paddle/receptor combination.
10. Raise the compression device off of the B.E.M., then lower it again until the force reading indicates 30 lb (133.5 N). Verify that the thickness reading indicates 5 cm.

6.3 Compression Chain Tension Adjustment

Perform this procedure after servicing or replacing the Compression Motor/Brake assembly or the Compression Clutch/Brake assembly.

1. Remove the lower Compression Device cover. Use care not to damage the bellows.
2. Manually move the Compression Device completely UP.
3. Loosen the hardware (A) that secures the lower compression chain sprocket mount to the C-arm frame (refer to Figure 8-21).
4. Adjust the sprocket tension screws (B) appropriately so that the chain deflection (near the center) is approximately 1/2 inch. Adjust both tension screws evenly.
5. Tighten the sprocket mount hardware (A).
6. Manually move the Compression Device completely down, then back up. Verify that the travel is smooth, and that the chain does not bind.
7. Use motorized compression to move the Compression Device completely down, then back up. Verify that the travel is smooth, and that the chain does not bind.
8. When complete, replace the lower Compression Device cover.

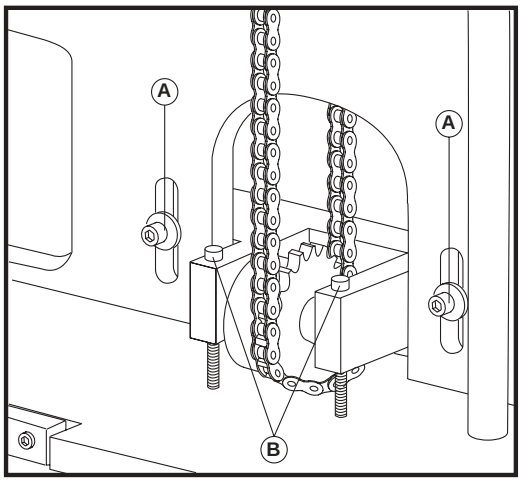


Figure 8-21: Compression Chain Tension Adjustment

6.4 Compression Thickness Potentiometer Mechanical Adjustment

1. Ensure the timing belt is mounted on upper clamp block. Refer to Figure 8-17.
2. Bring the compression device to the bottom of its travel.
3. With clamp screw (Item A, Figure 8-11) loosened, rotate the potentiometer in a counterclockwise direction (when viewed from the right side of the C-Arm assembly) until it bottoms out, then make one full turn of the pot in a clockwise direction.
4. Thread the timing belt through the pulleys, ensuring the potentiometer does not move and the timing belt does not twist.
5. While holding on to the bottom of the timing belt, raise the compression device to the top of its travel.
6. Insert the timing belt through the lower clamp on the bearing block assembly (refer to Figure 8-10) and tighten the screws enough to hold the belt in place.
7. Affix the Field Service Belt Adjustment Tool (PN 9-061-0107) to the bottom of the timing belt and loosen the screws securing the belt in the bottom clamp (see Figure 8-10). Tighten screws.
8. Install the 18 x 24 cm Bucky device and 18 x 24 cm paddle onto the compression device.
9. Center 1 cm of B.E.M. or acrylic on the IRSD. Move the compression device down until the paddle is touching the B.E.M. (or acrylic).
10. Rotate the potentiometer fully clockwise.
11. Attach an Ohmmeter between the red and white wire connections on the potentiometer posts.
12. Rotate potentiometer shaft counterclockwise till Ohmmeter reads between 500 and 600 ohms.
13. Tighten clamp screw.

6.5 Setting—Force Load Cell

This procedure sets the Host Microprocessor for the installed compression force load cell. This setting is factory configured. Only change this setting after replacing the assembly.

1. Remove the Compression Device cover to expose the compression force load cell. Remove the load cell from the compression device.
2. Install the replacement load cell and note the name of the manufacturer. Replace the Compression Device cover.
3. Set the M-IV to the calibration mode (S6 switch 4 = ON). Set the Host Microprocessor for the Force Load Cell selection mode (S4 = 5; S6 switch 8 = ON).
4. Press Select (S2) until the installed compression force load cell displays (i.e., REV or LCC). Set S4 = 5; S6 switch 8 to OFF, then return the Host to normal operation (S6 switch 4 = OFF).
5. Perform the Compression Force Calibration, and the Compression Thickness Calibration before releasing the unit to the user.

6.6 Compression Accessory Detect Board Verification

A strip of tape, on the rear of each Compression Paddle, blocks the 4 optical sensors on the Compression Accessory Detect Board. The strip is patterned using reflective and non-reflective material. Blocking an optical sensor with reflective material causes that sensor to generate a logic high signal; blocking it with non-reflective material keeps the sensor at a logic low.

The combination of these highs and lows generate the signals which are used to determine the attached compression accessory. Use Table 8-9 to verify the optical sensor combinations for each Compression Paddle. Note that "H" signifies a logic high (reflective), while "L" signifies a logic low (non-reflective).

Table 8-9: Accessory Sensor Combinations

Paddle	ISO1	ISO2	ISO3	ISO4
18 x 24 cm	H	L	L	L
10 cm Spot (Mag)	L	H	L	L
10 cm Loc (perf.)	H	H	L	L
10 cm Loc (square)	L	L	H	L
7.5 cm Mag Spot	L	L	H	H
15 cm Mag Spot	L	H	H	L
15 cm Loc (perf.)	H	H	H	L
15 cm Loc (square)	L	L	L	H
24 x 30 cm	H	L	L	H
7.5 cm Contact Spot	L	H	H	H
15 cm Contact Spot	H	H	L	H
10 cm Contact Spot	H	L	H	L

6.7 Image Receptor Detect Board Verification

A strip of tape, on the rear of each image receptor, blocks the four optical sensors on the Image Receptor Detect Board. The strip is patterned using reflective and non-reflective material. Blocking an optical sensor with the reflective material causes that sensor to generate a logic high signal; blocking it with the non-reflective material causes the sensor to remain at a logic low.

The combination of these highs and lows generate the signals which are used to determine the installed image receptor holder.

Use Table 8-10 to verify the optical sensor combinations for each image receptor. Note that "H" signifies a logic high (reflective: 3.5 - 5.0 VDC), while "L" signifies a logic low (non-reflective: 0.5 - 1.5 VDC).

Table 8-10: Image Receptor Sensor Combinations

Paddle	ISO1	ISO2	ISO3	ISO4
18 x 24 cm Bucky	H	L	L	L
Magnification Table	L	H	L	L
24 x 30 cm Bucky	H	H	L	L
18 x 24 cm Cassette Holder	L	L	H	L
24 x 30 cm Cassette Holder	H	L	H	L

Chapter 9: Parts List

1.0 Introduction

This Chapter of the manual provides tabular listings of the replacement parts for the M-IV Mammography System. Part numbers and descriptions are provided for component identification.

1.1 The Replacement Parts Lists

The replacement parts list is divided into two parts as follows:

- **Part Number :** this is the order number for the part. The LORAD Service Department will require this number when placing an order.
- **Description:** identifies the part by name.

Table 9-1: Remote Console Replacement Parts

TABLE 9-1: REMOTE CONSOLE REPLACEMENT PARTS		
PART NUMBER	**DESCRIPTION**	**FIGURE NUMBER**
4-000-0214	Assy, AutoFilm ID	Figure 6-6
9-200-0337	Kit, FMIM4 Bar Code Reader	Figure 6-1
1-451-5023	DC Power Supply	Figure 6-1
4-000-0010	Assy, Floppy Drive	Figure 6-7
1-070-1013	Fuse 4A, 250V (F1)	Figure 6-1
1-070-1011	Fuse 2A, FB (F2)	Figure 6-1
1-070-1007	Fuse 0.5A, 250V (F3, F4)	Figure 6-1
9-400-0099	Kit, Mounting Shield and Display M4	Figure 2-6
9-400-0116	Kit, Sub-Assy Shield	Figure 2-6
4-000-0284	Assy, Display and Mount	Figure 6-5
1-092-0035	Keyboard, Operator Interface	Figure 3-4
1-003-0357	Assy, Operator Console Interface Microprocessor Bd	Figure 6-1
1-003-0272	Assy, X-Ray Switch (Left)	Figure 6-4
1-003-0278	Assy, X-Ray Switch (Right)	Figure 6-3

Table 9-2: C-Arm Replacement Parts.

TABLE 9-2: C-ARM REPLACEMENT PARTS		
PART NUMBER	**DESCRIPTION**	**FIGURE NUMBER**
3-530-0013	Stud, Breast Tray (AEC Det Position Handle)	Figure 8-19
4-000-0040	Assy, Collimator	Figure 8-2
1-080-0011	Lamp, Collimator - 24 V, 150 W	Figure 8-2
1-080-1008	Lamp Holder	Figure 8-2
1-003-0461	Assy, Compression Accessory Detect PCB	Figure 8-14
2-230-3006	Pulley, Timing Belt	Figure 8-17
4-000-0266	Assy, Compression Cover, Upper	Figure 5-5
1-003-0465	Assy, Compression/AEC Position Display Right	Figure 8-13
1-003-0466	Assy, Compression/AEC Position Display Left	Figure 8-13
2-230-2006	Chain, Roller #25	Figure 8-10
2-230-2001	Master Link #25 Chain	Figure 8-10
4-000-0120	Assy, Compression Cover, Lower	Figure 5-5
2-155-0006	Slip Clutch, Compression Device	Figure 8-15
2-320-0034	Gear Motor, 24 VDC	Figure 8-3
1-195-3053	Pot WW 10T 5K Ohm	Figure 8-3
2-200-0016	Fan, 24 VDC, 5.5 CFM (Collimator Assy)	Figure 8-2
2-200-0010	Fan, 24VDC (Tubehead Cooling)	Figure 8-1
1-003-0289	Assy, Filament Protection Board	Figure 8-1
4-000-0141	Image Receptor	Figure 8-3
4-000-0139	AEC Assembly, New	Figure 8-20
1-003-0348	Assy, AEC Detector Board	Figure 8-20
1-003-0302	Assy, Image Receptor Accessory Detect Board	Figure 8-18
1-003-0293	Assy, Image Receptor Microprocessor Board	Figure 8-19
4-000-0039	Assy, Mirror/Filter	Figure 8-2
3-441-0010	Rod, Bellows	Figure 8-12
2-230-4001	Timing Belt (3/32 x 32 PIT	Figure 8-10
1-003-0474	Assy, Tubehead Motor Driver Board	Figure 8-9
1-003-0300	Assy, Tubehead Microprocessor Board	Figure 8-9
4-000-0292	Assy, Tubehead Switch (Left)	Figure 8-8
4-000-0291	Assy, Tubehead Switch (Right)	Figure 8-8
9-400-0113	Kit, X-Ray Tube, Toshiba (E7290A)	Figure 8-5
9-400-0112	Kit, X-Ray Tube, Varian (M113R)	Figure 8-5
9-400-0212	Kit, X-Ray Tube, Varian (M113R Elite)	Figure 8-5

Table 9-3: Gantry Replacement Parts

TABLE 9-3: GANTRY REPLACEMENT PARTS		
PART NUMBER	**DESCRIPTION**	**FIGURE NUMBER**
1-003-0334	Assy, C-Arm Microprocessor Board	Figure 7-1
1-003-0333	Assy, Filament Control Board	Figure 7-1
3-000-5020	Assy, Footswitch	Figure 1-2
4-000-0233	Assy, Footswitch Connector	Figure 2-5
1-070-1119	Fuse 30A, 600V FB (F19, F20) Power Dist	Figure 5-9
1-070-1114	Fuse 15A, 600V FB (F17, F18) Power Dist	Figure 5-9
1-070-1332	Fuse, KLK-D25A, 600V (F22) Power Dist	Figure 5-10
1-070-1333	Fuse, Fast-Acting 8A, 600V (F21) Power Dist	Figure 5-10
1-070-1083	Fuse, SB, 8A, 250V (F23, F25) Power Dist	Figure 5-10
1-070-1080	Fuse, SB, 5A, 250V (F11, F12, F15, F16, F24) Power Dist	Figure 5-9, 5-10
1-070-1072	Fuse, SB, 2A, 250V (F3, F4)	Figure 5-9
1-070-1275	Fuse, SB, 10A 250V (F1, F2, F5, F6, F7, F8, F9, F10)	Figure 5-9
1-070-1079	Fuse, SB, 4A, 250V (F13, F14)	Figure 5-9
1-003-0335	Assy, Gen. Microprocessor Board	Figure 7-1
4-000-0014	Assy, High Voltage Generator M-IV	Figure 7-1
1-003-0266	Assy, Host Microprocessor Board	Figure 7-1
1-003-0354	Assy, Mains Power Board	Figure 7-1
1-070-5019	Fuse 1/32A SB, 250V (F1) Mains Power Board	Figure 7-1
1-070-1062	Fuse 1/2A SB, 250V (F2) Mains Power Board	Figure 7-1
1-003-0288	Assy, Motor/Lamp Control Board	Figure 7-1
4-000-0207	Assy, Power Distribution	Figure 7-1
1-003-0341	Assy, Power Distribution Board	Figure 7-1
1-003-0330	Assy, Power Supply Interconnect Board	Figure 7-1
1-003-0301	Assy, Rotation Display Board	Figure 7-1
1-003-0336	Assy, Rotor Control Board	Figure 7-1
1-003-0303	Assy, VTA Motor Driver Board	Figure 7-1
1-003-0347	Assy, ±15V Power Supply (StereoLoc II ready units only)	Figure 7-1

Table 9-4: Miscellaneous Tools/Items

TABLE 9-4: MISCELLANEOUS TOOLS/ITEMS	
PART NUMBER	**DESCRIPTION**
9-061-0106	Tool, 1/4lb Belt Adjustment
2-580-0506	Adhesive LOCTITE 242, Blue
2-580-0203	Grease, Synthetic
9-200-0426	Kit, M4 Poweraid Upgrade (Mobile application only)
2-580-0207	Grease, Mobile XHP222SPCL

Appendix A: Specifications

1.0 M-IV Series System Specifications

The following section details the M-IV Series specifications, including performance specifications, x-ray tube and exposure specifications, compression specifications and beam limiting specifications.

1.1 Electrical Input Specifications

Mains Voltage

200, 208, 220, 230, or 240 VAC

nominal (tap selectable at installation)

±10%, 50/60 Hz permanently wired.

Mains Impedance

Maximum line impedance not to exceed 0.20 ohms for 208, 220, 230, 240 VAC, 0.16 ohms for 200 VAC (IEC 601-2-7, Table 101).

Maximum Power Consumption

6.5 kVA for 5 second duration

Standby Current

2.0 A nominal over the entire mains voltage and frequency range

Maximum Line Current

35 Amps for 5 seconds

Circuit Breaker Rating

25 A - time delay curve to allow for inrush currents. 200% overload for 7 seconds.

Duty Cycle

Full load 5 seconds on, 30 seconds off

1.2 Operating Environment

Temperature Range

10° C to 40° C (50° F to 104° F)

Relative Humidity Range

30% to 75% non-condensing

ESD Susceptibility

3 kV for contact discharge to non-grounded conductive accessible parts. 8 kV air discharge to all other accessible parts. (Test Method: IEC 801-2; Test Levels IEC 601-1-2)

EMI Susceptibility

The system is immune to levels of EMI radiation per IEC 601-1-2.

EMI Generation Limits

The system complies with the requirements of IEC 601-1-2

Input Line

Surge, fast transient/burst per IEC 601-1-2

1.3 Storage Environment

Temperature Range

-25° C to +60° C (-13° F to 140° F)

Humidity

Zero to 95% humidity—non-condensing (not packaged for outdoor storage)

1.4 Unit Measurements

Gantry with C-arm

Height—75″ (190.5 cm); Crated: 86″ (218 cm)

Width—25.5″ (64.2 cm); Crated: 40″ (102 cm)

Depth—50.25″ (128 cm); Crated: 54″ (137 cm)

Weight—800 lb (360.7 kg); Crated; 1050 lb (473 kg), includes shield assembly.

Remote Console

Height—35.5″ (90.2 cm) minimum to front; 42" (106.7 cm) maximum at rear

46.5″ (118.0 cm) to top of display at maximum height

Width—21.0″ (53.3 cm) at shield, including EMO switch

—32″ (81.3 cm) including radiation shield support (min.)

—36.5″ (92.7 cm) at shield with Bar Code Reader installed

Depth—17″ (43.2 cm) including radiation shield

Weight—214 lb (96.3 kg); Crated; 260 lb (117 kg), includes accessories

Radiation Shield

Height—74.5″ (189.2 cm) max. height installed

Width—32″ (81.3 cm)

Pb equivalent—0.5 mm Pb equivalent (min.)

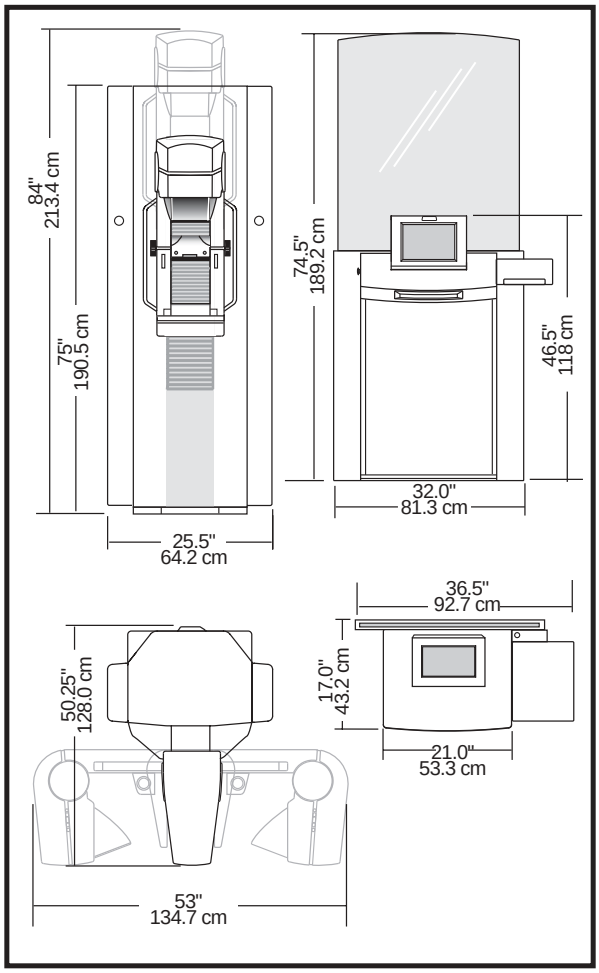


Figure A-1: M-IV System—Dimensions

1.5 C-arm Specifications

Motorized Rotation

Variable speed (18° per second maximum). Service selectable between 50% through 100% of full speed and displayed on the host microprocessor as 40% through 90% in increments of 5%. Motor Control provides soft start and dynamic braking.

C-arm Rotation

+195° +2°/-0° to 0° ±0.5° to -150° +0°/-2° with electrical detents at 0°, +90° and -90°.

Rotation angle is displayed on both sides of Gantry.

Vertical Travel

25" to 55" (63.5 cm to 140 cm) from Bucky surface to floor for C-arm positions at both 0° and 90°. Movement controls on both sides of C-arm and on footswitch.

Alignment of Focal Spot, Compression Device, and Image Receptor

The focal spot of the x-ray tube is located so that the ray falling on the edge of the image receptor closest to the chest wall is perpendicular to the image receptor. The system allows the plane formed by the focal spot and the chest wall of the device to be perpendicular to that ray, and motion of the compression device provides parallel compression of the breast with respect to the plane of the image receptor. The compression paddle is adjustable, chest wall to nipple, to provide for this alignment requirement. (MQSA)

Source to Image Distance (SID)

65 cm from the nominal position of the Large Focal Spot to the image receptor (film) within the Bucky.

Magnification

1.8x for objects 22.5 mm above the magnification stand breast support surface (breast support surface is at approximately 1.7x). This provides a balance between resolution, signal to noise, and scatter reduction. The breast support surface material is made up of carbon fiber. The magnification table is constructed as a tower to provide rigidity.

Image Receptor Support Device

The Image Receptor Support Device (IRSD) is removable from the C-Arm. There is an electrical interlock to prevent X-ray exposure when removed. The IRSD houses the 3-cell AEC detector, movable to 7 positions.

The IRSD limits the x-ray transmission to no more than 0.1 mR for the maximum technique exposure to comply with 21 CFR, section 1020.31 and meets the 1 μGy per exposure as defined by IEC 601-1-3, section 29.207.2.

1.6 Compression Specifications

Manual Compression Force

Limited to a maximum of 67.4 lb (300 N), +0 lb /-20 lb (+0/-89 N) from 0° to ±90° C-arm rotation. Not less than 38 lb (169 N) for C-arm angle range greater than +150° and an angle less than -150°.

Motorized Compression

Functions in three operating modes, user selectable through software.

- *Pre-Compression Force*
  15.7 lb ±0/-5 lb to 30 lb ±5 (70 N +0/-22.3 N to 133.5 N ±22.3 N)
- *Full-Range Compression Force*
  20 lb ±5 to 40 lb ±5 (84.9 N ±22.3 N to 178 N ±22.3 N)
- *Dual Mode Compression*
  Provides Pre-Compression force upon first activation of compression switch, then if switch is activated within 2 seconds, the force is increased incrementally for each additional activation, up to the user selected Full-compression force.

Compression Controls

Up/Down controls on both sides of C-arm and on 2-position footswitch (Motorized). Handwheel on both sides of Compression Device (Manual).

Compression Release

Motorized Release mode controlled by push-buttons on both sides of the C-arm and on the Operator Control panel. User selectable automatic release mode raises Compression Device upon exposure termination available via Setup Mode data field. All release functions, including automatic compression release, are disabled if the Localization paddle is installed.

Automatic Compression Release

Moves the compression device to a distance of 5 cm, 7.5 cm, 10 cm, or 12.5 cm, selected upon installation. For Mag., this may be less.

Backdrive After Compression

Does not exceed 1.5 mm in either motorized or manual drive between -90°, 0° and +90° positions, and no greater than 3 mm at all other positions.

Compression Down Motion Variable Speed

Selectable between approximately 10% through 100% of full speed and displayed on host microprocessor as 0% through 90% in increments of 10%.

Compression Force Display

LED Display on Compression Device shows the compression force through the range of 10 lb to 67.4 labs. (44.5 N to 300 N).

Compression Force Display Accuracy

Display accuracy of ±4.5 labs (±20 N).

Compression Thickness Display

Two LED Displays on Compression Device measures between 0 and 15 cm above image receptor. The displays compensate for type of image receptor installed (i.e., no receptor, cassette holder, Bucky and magnification device). Display is in 0.1 cm increments. The display is visible from both sides of the patient.

Compression Thickness Accuracy

±0.5 cm for thicknesses between 0.5 cm and 15 cm

Compression Paddles

Compression paddles are transparent and the full field paddles are marked with location of the AEC sensor positions. The paddles are composed of polycarbonate. The sensor position marking is not detectable on film when imaged with 1 cm of acrylic attenuator at 20 kV to an optical density of 1.2 OD. Paddle attenuation is less than 15% (reduction of mrad/mAs) at 25 kV. The paddles provide a parallel plane to the image receptor under 25 lb of compression force. The paddles are adjustable to provide the focal spot, compression device and image receptor alignment requirement.

The following paddles are available:

- *24 x 30 cm Compression paddle*
- *18 x 24 cm Compression paddle*
- *24 x 30 cm F.A.S.T. paddle*
- *18 x 24 cm F.A.S.T. paddle*
- *15 cm Contact paddle*
- *10 cm Spot Contact paddle*
- *15 cm Magnification paddle*
- *10 cm Spot Magnification paddle*
- *15 cm Perforated Local paddle*
- *10 cm Perforated Local paddle*
- *15 cm Rectangular Open paddle*
- *10 cm Rectangular Local paddle*
- *Frameless Spot paddle*
- *15 cm Ultrasound paddle*
- *Small Breast paddle*
- *7.5 cm Spot Mag paddle*
- *7.5 cm Spot paddle*

1.7 X-ray Tube Specifications

Focal Spot (NEMA / IEC)

Large Focal Spot (0.3 mm)
Small Focal Spot (0.1 mm)

Tube Voltage

20 kV to 39 kV (maximum)

Tube Current (maximum)

Large Focal Spot = 100 mA minimum between 25 and 32 kV

Small Focal Spot = 30 mA minimum between 25 and 32 kV

Anode Rotation

180 Hz (9600 RPM minimum)

Anode Angle

Bi-angular—Large focal spot at 16°, Small focal spot at 10°. X-ray tube angle at 6° to provide 22° (Large) and 16° (Small) anode to film plane angle. Provides film coverage of 24 x 30 cm for Large Focal Spot and 18 x 24 cm for Small Focal Spot (magnification).

Anode Material

Molybdenum

X-ray Window

Beryllium—0.8 mm thickness (maximum)

Beam Quality for Mo/Mo and Mo/Rh Operation

1.8 X-ray Tube Housing Specifications

Over Temperature Protection Sensor

Internally connected in series with the stator common lead.

Maximum Temperature Tube Housing Surface

55° C

Maximum Temperature Tube Head Cover Surface

41° C

Safety Class

IEC 601-2-8, Class 1, IEC 601-2-8

1.9 X-ray Beam Filtration and Output Specifications

Inherent Tube Filtration

0.0 mm Al equivalent

Added Filtration

2-position filter changer mechanism that houses a 25 micron (0.025 mm) Molybdenum foil filter, and a 25 micron (0.025 mm) Rhodium filter. (The filters are placed at a 22° angle which provides an effective 27.5 micron thickness.) Filter is user selectable in all exposure modes except Auto-Filter Mode, where it is selected automatically.

HALF-VALUE LAYER Must use type 1145 aluminum, 99.9% pure. (All units are in millimeters of aluminum.)		
Target-Filter Combination	**Minimum HVL**	**Maximum HVL**
Mo/Mo with compression paddle in place	kV/100 +0.03	kV/100 +0.12
Mo/Rh with compression paddle in place	kV/100 +0.03	kV/100 +0.19
Mo/Mo without compression paddle in place	kV/100	

Radiation Output

Equal to or greater than 800 mR/second (7.16 Gy/sec.) for at least 3 seconds (output measured through the Compression Paddle, 4.5 cm above the breast support, 4.0 cm from the chest wall edge, using exposure techniques of Mo/Mo target/filter, large focal spot, 28 kV). (MQSA)

1.10 X-ray Collimation

System detects the attached image receptor and automatically adjusts the field size to limit the beam as required by 21 CFR. With no accessory installed, the beam is limited to the size of the image receptor support device (18 x 24 cm).

1.11 Light Field Specifications

Collimator Lamp

Illuminates for 30 seconds, ±5 seconds, upon pressing a Light Field button on either side of the x-ray tubehead and from the operators console (key F6), or by pressing a compression Down Function. Extinguishes automatically upon exposure initiation.

Light Field Illuminance

160 lux (minimum)—meets 21 CFR 1020.31 requirements. Lamp is adjustable to provide alignment of the light field to the x-ray field.

Light Field-to-X-ray Field Congruency

X-ray field to light field misalignment for both length and width is $\leq$ 2% of the SID (1.30 cm). Comply with IEC 601-1-3 and 21 CFR.

1.12 High Voltage Generator Specifications

Output Rating

3.2 kilowatt maximum (isowatt), 100 mA at 32 kV

Ripple

2% or less (typical), maximum 4%

Topology

Pulse width modulated High Frequency, active servo controlled

Duty Cycle

5 seconds on, 30 seconds off

Table A-1: kV/mA Range

kV	Large	kV	Small
20	75 mA	20	20 mA
21	80 mA	21	22 mA
22	85 mA	22	24 mA
23	90 mA	23	26 mA
24	95 mA	24	28 mA
25-32	100 mA	25-32	30 mA
33	85 mA	33-34	28 mA
34-35	80 mA	35-37	26 mA
36-37	75 mA	38-39	24 mA
38-39	70 mA		

mAs Range

The M-IV employs an integrating mAs timer for use as manual timing and as the backup timer. An additional hardware safety timer is employed.

Manual mAs Range:

TABLE 1 (default): 3 mAs through 500 mAs, 23 steps (3, 4, 5, 6.4, 8, 10, 12.5, 16, 20, 25, 32, 40, 50, 64, 80, 100, 125, 160, 200, 250, 320, 400, and 500).

TABLE 2 (user selected): 3 mAs through 500 mAs, 59 steps (3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 220, 240, 260, 280, 300, 325, 350, 375, 400, 425, 450, 475, 500).

Mag Manual mAs Range:

TABLE 1: 3 mAs through 125 mAs, 17 steps (3, 4, 5, 6.4, 8, 10, 12.5, 16, 20, 25, 32, 40, 50, 64, 80, 100, and 125).

TABLE 2: 3 mAs through 150 mAs, 41 steps (3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, and 150).

1.13 Accuracy, Reproducibility and Linearity Specifications

Reproducibility

0.05 coefficient of variation for 10 consecutive exposures (21 CFR).

Linearity

0.10 for adjacent mAs selections per the following:

(X1 - X2) is less than or equal to 0.10 (X1 + X2) where X1 and X2 are average mR/mAs values for consecutive exposures (21 CFR).

kV Accuracy

Within 1 kV of the indicated kV level

mAs Accuracy

±5% or ±2mAs,whichever is greater, from indicated, measured in the ground side of the tube circuit.

Post mAs Accuracy

±5% or ±2mAs, whichever is greater, from actual mAs

mA Accuracy

The actual value will not differ by more than +5% for the indicated value.

1.14 Image Receptors

Standard Types

18 x 24 cm Full-pass Linear Bucky

24 x 30 cm Full-pass Linear Bucky

18 x 24 cm HTC Bucky

24 x 30 cm HTC Bucky

StereoLoc II

DSM

Magnification Table

1.15 Automatic Exposure Control (AEC) Specifications

AEC Detector

Solid-state, three square centimeter active sensing area. The detector is centered laterally in the Image Receptor Support Device and may be moved forward or rearward to one of 7 detent locations. The detent position of the AEC sensor will be displayed on the corresponding LED on the AEC Position Indicator, and its position is indicated on the AutoFilm ID marker. Detents are provided in 1.7 cm increments.

AEC kV and Thickness Tracking

AEC compensates for kV between 20 kV and 39 kV, as well as for breast thickness tracking including different breast compositions.

Optical density is within 0.12 OD from the mean optical density value at any point within the clinically defined range of kVs for breast thicknesses between 2 and 8 cm of breast tissue equivalent material.

Exposure Termination

The AEC system determines if the exposure will reach the Backup Time, and if so, will then terminate the exposure within one of the following limits:

1) 50 ms (100 ms in Auto-kV and Auto-Filter modes)

2) 5 mAs (10 mAs in Auto-kV and Auto-Filter modes)

3) with an entrance exposure to the ACR Accreditation Phantom of less than 50 mR (100 mR in Auto-kV and Auto-Filter modes).

Indication is made to the operator. A manual reset is required to continue.

Density Range

There are 11 density adjustment steps, -5 through +5. These steps are adjustable between 6%, 8%, 10% and 12.5% of adjustment mAs values. Default setting is 10% and is set upon installation by service engineer.

Manual Exposure Mode

In this mode kV, mAs, and filter are all selectable. When the kV is decreased to 20 kV, the mAs will be adjustable from 3 to 100 125 mAs for specimen radiography.

Auto-Time Exposure Mode

In this mode kV, filter, and density are all selectable—system terminates exposure automatically at the mAs value that will yield the calibrated optical density. System displays the Post-mAs value after exposure termination and remains displayed until initiation of next molybdenum or rhodium filter selected.

The exposure mAs may be modified up to ±80% by incrementing the DENSITY function. If the system determines the exposure will exceed the Backup time, exposure will be limited within one of the following limits:

1) 50 milliseconds
2) 5 mAs
3) with an entrance exposure to the ACR Accreditation Phantom of less than 50 mR.

Indication is made to the operator. A manual reset is required to continue.

Auto-kV Exposure Mode

In this mode filter and density are selectable.

Linear Bucky Operation

When Auto-kV and the Molybdenum filter are selected, the kV will default to 25 kV. The starting kV may be incremented to 26 kV by the operator. If the Rhodium filter is selected, the kV will default to 28 kV. Upon exposure initiation, the AEC signal is sampled and the kV may be incremented upward to a maximum of 30 kV if the Molybdenum filter is selected, or 32 kV if the Rhodium filter is selected. The exposure will be terminated at a mAs value near one of the three mAs windows, 125 mAs, 165 mAs, 200 mAs, or the automatic 200 mrad window (selectable by operator). The final kV and post-mAs will be displayed upon termination of exposure.

HTC Bucky Operation

When Auto-kV and the Molybdenum filter are selected, the kV will default to a value determined by the Compression Height Threshold setting. The kV will default to 24 kV for a compression height value less than the threshold, or to 25 kV for compression height values above the threshold. When the Rhodium filter is selected, the kV will default to 28 kV. The exposure will be terminated at a mAs value near one of the three mAs windows, 125 mAs, 165 mAs, 200 mAs, or the automatic 200 mrad window (selectable by operator). The final kV and post-mAs will be displayed upon termination of exposure.

Note…The sample pulse determines what kV is selected.

Auto-Filter Exposure Mode

In this mode, density is selectable. Auto-Filter Exposure mode provides full automatic operation of all technique factors. When this mode is selected, the kV defaults to 25 kV. The exposure is initiated and sampled to determine if the kV needs to be increased upward to provide an exposure within the 200 mAs or the automatic 200 mrad window. When determined by the Auto-Filter algorithm, the exposure will be momentarily interrupted and the Rhodium filter will be moved into the beam in place of the Molybdenum filter. After the kV or kV/filter has been selected by the algorithm, the Auto-Time function completes the exposure. The final kV, post-mAs, and filter will be indicated upon termination of the exposure.

Note…Auto-Filter exposure mode is not available for magnification studies.

200 mrad Screen-Film Speed Requirements

The 200 mrad window is most effective when the screen-film speed is 170 or less. It is generally not necessary to use the 200 mrad window when the screen-film speed is greater than 170. Please consult your Medical Physicist regarding screen-film combinations and the 200 mrad window for specific recommendations.